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Cover: Canada's Kluane National Park and Alaska's Wrangell-St. Elias National Monument, a vast region of glaciers and icefields, towering mountains, glacier-fed lakes and rivers, forests, tundra and wildlife, is the first international site to receive a UNESCO-World Heritage plaque. Ceremonies to unveil the Kluane plaque were planned for August 2 at Kathleen Lake in the Yukon. Pictured is the Kaskawulsh glacier in Kluane National Park.

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Robert Allen

The World Conservation Strategy: What it is and What it Means for Parks

Arguably the crucial weakness of human beings is that we have not yet learned to live with the one indispensable feature of our world: the biosphere, the thin covering of the planet that contains and sustains life. This failing has already led to a virtually permanent reduction in the productive and regenerative capacities of the earth. Now we have reached a turning-point at which, depending on if and how we act, matters will be resolved for better or worse. Unless concerted action is taken immediately, there will be a further decline in the planet's capacity to support people. Subsequent generations will be left a sorry heritage: less productive land; less diversity; less room for manoeuvre; fewer options; more people. The decision is not one we can postpone or ignore. Doing nothing is itself a decision to allow the world to be a much less fruitful and promising place than that into which we were born.

The World Conservation Strategy, which was launched worldwide on 5 and 6 March 1980, is an attempt to stimulate the action needed, describe the priority problems, and propose the most effective ways of dealing with them. The Strategy reflects the expertise and experience of IUCN and its members — more than 400 government agencies and nongovernmental organizations concerned with the management of living resources, and more than 700 scientists and other specialists in conservation — as well as of UNEP, FAO, UNESCO and WWF. But it is more than the sum of their views. Although few if any of the facts, comments or recommendations in the Strategy will strike the reader of PARKS as new, the Strategy as a whole represents a radical shift in the way conservationists see themselves, the relevance of conservation to human affairs, and the relationship between conservation and development. This shift can be expressed in five statements.

First, conservation is not "just" about wildlife: conservation is concerned with agriculture, fisheries, forestry, genetic resources — in short, with all plants, animals and microorganisms and with the non-living elements of the environment on which they depend.

Second, conservation is not preservation. It *includes* preservation; but it also includes maintenance, sustainable use, restoration, and enhancement of the natural environment. In effect, the biosphere is like a self-regenerating cake, and conservation is the conduct of our affairs so that we can have our cake and eat it too. Conservation's job is to ensure that certain bits of the biosphere are not consumed and consumption of the rest of it is kept within certain limits, so that the biosphere can renew itself and provide for continuing consumption. This means doing three things:

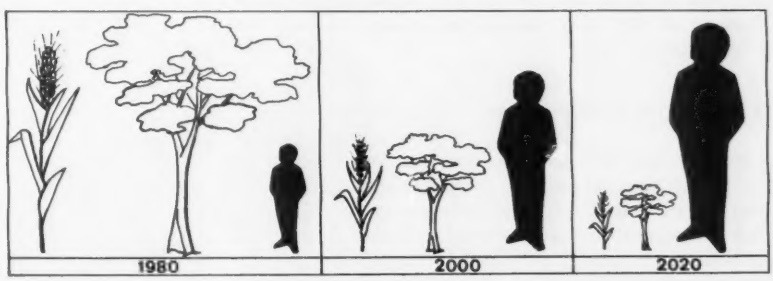
1. Maintaining essential ecological processes and life-support systems;
2. Preserving genetic diversity;
3. Using species and ecosystems sustainably.

Third, viewed in this light, conservation is essential for development, because without it development cannot be sustainable. Increases in production will be short-lived and will be followed by declines if their achievement incurs a reduction in Earth's capacity to produce. There are, unfortunately, many demonstrations of this: loss of prime farmland to

Why a world conservation strategy is needed

A world strategy for the conservation of Earth's living resources is needed now because:

1. Living resources essential for human survival and sustainable development are increasingly being destroyed or depleted. At the same time human demand for those resources is growing fast. The problem is illustrated here. If current rates of land degradation continue, close to one third of the world's arable land (symbolized by the stalk of grain) will be destroyed in the next 20 years. Similarly, by the end of this century (at present rates of clearance), the remaining area of unlogged productive tropical forest will be halved. During this period the world population is expected to increase by almost half – from just over 4,000 million to just under 6,000 million. The predicament caused by growing numbers of people demanding scarcer resources is exacerbated by the disproportionately high consumption rates of developed countries.



2. The action required to cure the most serious current conservation problems and to prevent still worse ones takes time: time for planning, education, training, better organization and research; and when such action is undertaken, it takes time for the biosphere to respond – reforestation, the restoration of degraded land, the recovery of depleted fisheries, and so on, are not instantaneous processes.

3. National and international capacities to conserve are ill-organized and fragmented – split up amongst sectors such as agriculture, forestry, fisheries and wildlife – with consequent duplication of effort, gaps in coverage, competition for money and influence, and conflict; and they have little influence on the development process, with the result that development, the principal means of tackling human problems, too often adds to them by destroying or degrading the living resource base of human welfare.

buildings, highways and erosion; abbreviation of the economic life of reservoirs, hydropower systems and irrigation systems, due to siltation as a result of inadequate watershed protection; collapse of fisheries due to overfishing.

Fourth, development is essential for conservation, because without it conservation cannot be sustainable either. In many developing countries especially, where plants, animals and their habitats are being destroyed primarily by a combination of poverty and population growth, the surest and most effective way of conserving those resources is probably a set of simple development measures: establishment of fuelwood plantations; provision of appropriate technologies (such as more efficient stoves); incentives and training to convert from shifting to settled agriculture; a direct stake in revenues from tourism; and so on. Unless such measures are taken, it is likely that traditional conservation measures (such as the establishment of protected areas and the strengthening of anti-poaching forces) will fail rather quickly or, worse, backfire.

Fifth, there needs to be much greater stress on strategic rather than tactical action. Tactical action is technical: it includes measures to check soil erosion, establish national parks, and control use of species and ecosystems. Such measures are indispensable and must continue to be taken, but they address symptoms not causes, and unless supported by strategic action are unlikely to succeed for long. This is a well-recognized problem and the usual response is to call for what might be termed basic action: basic action includes measures to stabilize human population numbers, reduce excessive consumption by the affluent, and alter economic relationships between developed and developing countries in favor of the latter. Such measures, too, are indispensable; but they demand an unusual degree of political will and international cooperation, which even the optimistic agree will take time to achieve — too much time to justify postponing other, strategic, action.

Strategic action is at the heart of the World Conservation Strategy. It comprises the measures necessary both to integrate conservation and development so that they are indeed mutually supportive and to strengthen each country's capacity to conserve its living resources. These include: preparing and implementing national and subnational conservation strategies; incorporating conservation into policy making; improving environmental planning and the allocation of land and water uses; improving legislation, organization, training and research; building support for conservation through education; and achieving conservation-based rural development. Such measures can be of great long-term as well as short-term benefit and can have enormous leverage, equipping countries not just to save one species or to protect one area, but to conserve all their living resources and develop in balance with the environment.

A strategy for protected areas

It might be concluded from the above remarks that the World Conservation Strategy dismisses parks and other protected areas as "tactical" and says little about them. This is not at all the case. The Strategy makes it clear that protected areas are essential for conservation (and hence for sustainable development); and it devotes considerable attention to four priority problems concerning the establishment and management of protected areas today. These are: lack of coverage; lack of knowledge; lack of integration; lack of security.

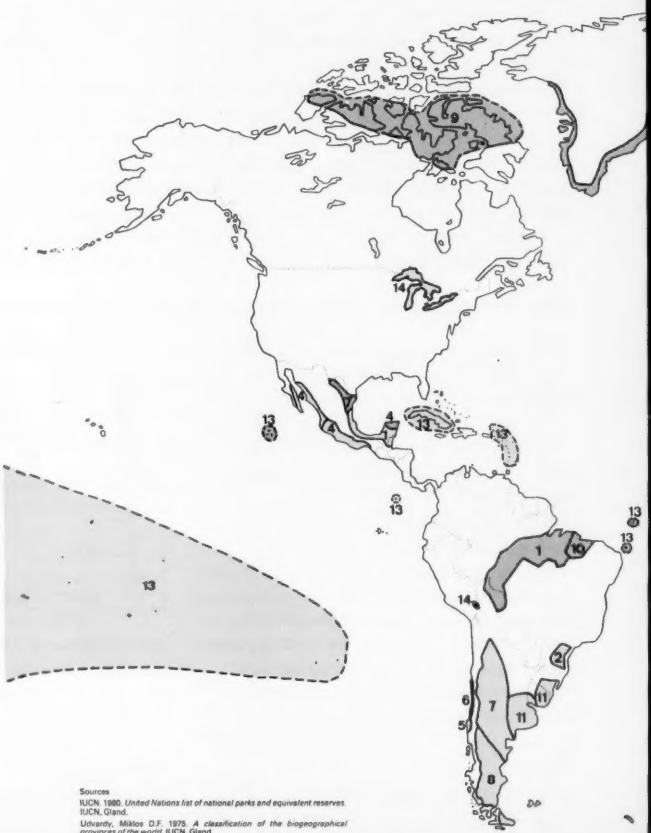
Lack of coverage. The most important role identified for protected areas by the Strategy is to preserve genetic diversity (the range of genetic variation found in the world's organisms). To discharge this role, there needs to be a comprehensive system of reserves protecting: the wild relatives of economically valuable and other useful plants and animals in their habitats; the habitats of threatened and unique (endemic) species; unique ecosystems; and representative samples of ecosystem types. Coverage of this last category is far from complete. Review of the distribution of protected areas of land alone shows that 35 of the world's 193 biogeographical provinces[1] have no national parks or equivalent reserves and a further 38, while having at least one park or reserve, are inadequately covered.[2] The Strategy comments that in many of the biogeographical provinces that appear adequately covered only a small proportion of ecosystem-types are protected and the protection of many

Notes

1. The 193 biogeographical provinces are those defined by Udvardy, Miklos D. F. 1975. *A classification of the biogeographical provinces of the world*. IUCN, Gland. The review was made by Harold K. Eidsvik of IUCN's Commission on National Parks and Protected Areas (CNPPA), using the *1980 United Nations list of national parks and equivalent reserves*. IUCN, Gland.

2. "Inadequate" coverage is where the total area protected by parks and reserves is smaller than 1000 km² (or smaller than 100 km² in the case of oceanic island provinces).

Priority biogeographical provinces of the land



Sources
IUCN. 1980. *United Nations list of national parks and equivalent reserves*. IUCN, Gland.
Udvardy, Miklos D.F. 1975. *A classification of the biogeographical provinces of the world*. IUCN, Gland.

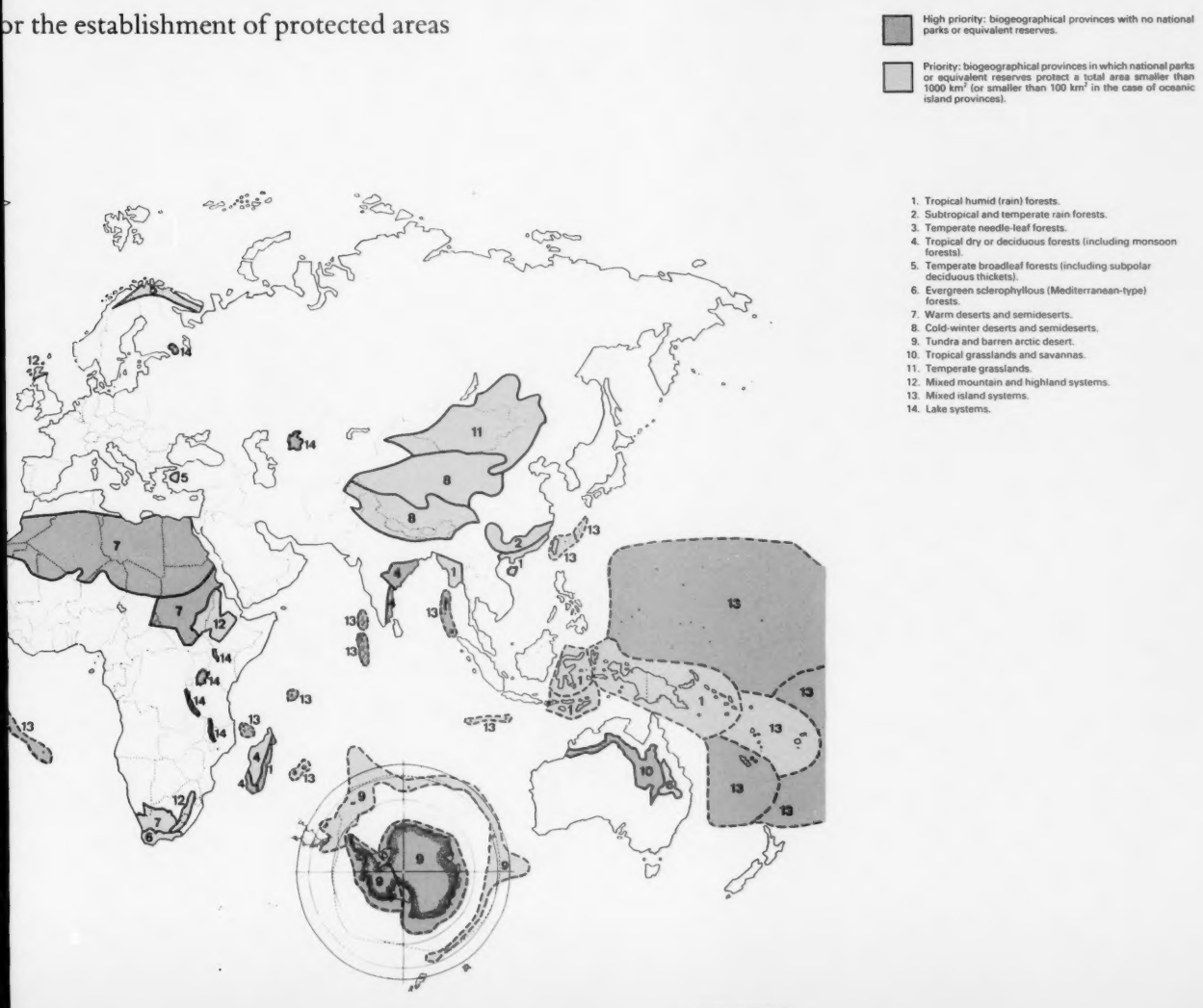
of these is inadequate. The situation is still worse for freshwater, coastal, and marine ecosystems.

Lack of knowledge. It is impossible to tell to what extent parks and reserves protect the other categories of genetic resource (the habitats of the wild relatives of economically valuable and other useful species; the habitats of threatened and endemic species; and unique ecosystems). Knowledge is so scant. The Strategy proposes that inventories of existing protected areas be made to find out what threatened, endemic and other important species may already be protected adequately. This is a daunting task; but until it is done it will not be possible to determine national — still less international — priorities for the establishment of additional protected areas. Another problem is that we are not yet sure that the size and distribution of existing areas are right for the job. Hence the Strategy calls for more research into the questions of minimum critical size and optimum distribution of reserves required to safeguard a given number and composition of species.

Lack of integration. One of the most serious problems confronting conservation is that it is ill-organized and fragmented — split up among sectors such as agriculture, forestry, fisheries and wildlife. The result: duplication of effort, gaps in coverage, competition for money and influence, and conflict. To overcome this problem, the Strategy recommends that every country review the mandates of all government agencies responsible for living resources and prepare a cross-sectoral conservation policy to integrate their work.

Lack of integration between institutions responsible for protected areas on the one hand and plant breeders and crop geneticists on the other hand is probably the main reason why the protection of one singularly important category of genetic resources — the wild relatives of cultivated plants — has been neglected. Although several international meetings (notably the UN Conference on the Human Environment in 1972) have urged the on site (*in situ*) protection of the wild relatives of crops, very little has apparently been done. No doubt this is because plant breeders

or the establishment of protected areas


High priority: biogeographical provinces with no national parks or equivalent reserves.
Priority: biogeographical provinces in which national parks or equivalent reserves protect a total area smaller than 1000 km² (or smaller than 100 km² in the case of oceanic island provinces).
1. Tropical humid (rain) forests.
2. Subtropical and temperate rain forests.
3. Temperate needle-leaf forests.
4. Tropical dry or deciduous forests (including monsoon forests).
5. Temperate broadleaf forests (including subpolar deciduous thickets).
6. Evergreen sclerophyllous (Mediterranean-type) forests.
7. Warm deserts and semideserts.
8. Cold-winter deserts and semideserts.
9. Tundra and barren arctic desert.
10. Tropical grasslands and savannas.
11. Temperate grasslands.
12. Mixed mountain and highland systems.
13. Mixed island systems.
14. Lake systems.

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have been more concerned with collection for off site (*ex situ*) protection in gene banks and the like; while those concerned with protected areas have concentrated on ecosystems and variation *among* species rather than variation *within* species. Unfortunately, reserves intended to protect representative or unique ecosystems will not necessarily safeguard the wild genetic resources that interest the plant breeder. Moreover the management systems for such reserves may not (and often do not) provide for adequate documentation of the species of interest or sufficiently allow for their evaluation and utilization by breeders. Yet it is particularly important that as many as possible of the reasons for establishing reserves are integrated and provided for, because this will help make each reserve more cost-effective and more secure.

Lack of security. Park planners and managers are only too familiar with the threats to protected areas: from poaching and encroachments by local hunters and farmers to the delisting of all or part of a reserve so that land can be used for some other purpose. The World Conservation Strategy proposes three responses: better planning and allocation of land and water uses; complementary rural development; and as equitable a distribution as possible of the costs and benefits of protected areas.

In the intense and increasing competition for land, parks are often the losers. They may either be restricted to areas that are marginal for agriculture (and sometimes not of the first priority for conservation); or, if they do happen to occupy potentially valuable farmland or forestland or a fine site for a dam, in the end those other uses may prevail. To avoid either fate, and to ensure that areas most in need of protection are indeed protected, the Strategy recommends that countries allocate land and water uses on the basis of ecosystem evaluations supplemented by environmental assessments.

Ecosystem evaluations are much the same as land evaluations or land capability assessments. But they apply also to water bodies; and they are intended to take account of the dynamic quality of ecosystems and the linkages between them. The procedure for allocating land and water uses proposed by the Strategy aims to match short-term and long-term demands for particular goods and services with the capacity — as determined by ecosystem evaluations — of particular ecosystems to supply them. Uses that depend on unique and irreplaceable ecosystem characteristics are given priority over other uses.

Ideally, this procedure should enable governments to apply simultaneously ecological, social and economic criteria and therefore to make informed choices before financial and other resources are irrevocably committed. It can suggest those development opportunities likely to be both productive and sustainable; and it can provide a means of comparing the advantages and disadvantages of protecting an area with those of using it in some other way. Good planning can help secure protected areas in other, more direct ways. For example, by anticipating the spontaneous settlement that generally occurs once a forest area is opened up by large-scale logging. Invariably such settlement is destructive — but it need not be if governments have a practicable plan for assisting settlers to develop the land sustainably, for providing firewood plantations or alternative fuels, and for protecting watersheds, the soil, and important genetic resources.

Earlier it was stated that development is essential for conservation. This is particularly the case with protected areas which almost invariably will be encroached by local communities if their access to fuel, food, forage and other products is restricted. Complementary development measures, including pasture improvement, the establishment of fuelwood plantations and the provision of credit or alternative food, fuel or fibre, are then essential. If they take time to give results they must be supplemented by measures bringing immediate benefits. For example, if a reserve is threatened by wood-cutting for fuel, it will be necessary not only to establish a fuelwood plantation but also to provide an alternative source of fuel that can be used at once. It would also be prudent to provide the community concerned with the means of conserving fuel supplies, such as more efficient cookers.

Protected areas can of course bring real benefits to local communities by assuring a regular supply of water or by providing habitat for wildlife which may be hunted outside the protected area; examples are the Royal Chitwan National Park in Nepal and the Amboseli National Park in Kenya. However, the community should also be able to share in new benefits, such as income from recreation and tourism. Although local communities may benefit indirectly from tourism if receipts by the national treasury are spent on such services as roads, water supply and health facilities, local commitment to a protected area can only be assured through provision of local advantages such as increased opportunities for employment and commerce.

Local communities are not the only people who may have to bear a disproportionate share of the costs of protected areas. Many countries particularly rich in genetic resources are developing ones that can ill-afford to bear alone the burden of their on site protection. The Strategy calls for an international mechanism by which those countries with an especially heavy responsibility can be compensated. A partial model is the World Heritage Fund of the World Heritage Convention. The Fund does not diminish the responsibility of each state to protect its unique natural areas, but it does provide a means of ensuring that areas of global significance are not lost because of a local lack of money or skills.

The assistance provided by the International Board for Plant Genetic Resources in the case of the off site protection of crop genetic resources is a start in the right direction. But the on site protection of all types of genetic resources should be supported, and contributions should come

Development can provide alternatives to this kind of forest – and park – destruction. Government incentives and training to convert people from shifting to settled agriculture, to establish fuelwood plantations and provide appropriate technologies for such basic needs as water and heat for rural populations could do much to sustain conservation. Photo: Douglas R. Shane

not only from governments and international organizations but also from the commercial enterprises which benefit directly from living resources.

Industries that depend on particular plant or animal species should sponsor the establishment and maintenance of protected areas for the preservation of those species. Commercial sponsorship should be regarded not as conferring special rights of use but in recognition of shared responsibility. However, it would be reasonable for the industries concerned to be able to use the areas for research and to draw on them for germplasm needed for breeding programmes.

Protected areas confer benefits and impose costs on different groups of people at different times. It will never be possible to redistribute those benefits and costs entirely equitably. But it is perfectly possible to recognize and minimize the problem — nationally, through complementary development projects and a direct share by local communities in revenues from tourism; and internationally through a global programme funded from public and private sources. Both sets of actions would help make parks and reserves more secure by enhancing their real, but little realized, contribution to sustainable development and human welfare.

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ORVs and Barrier Beach Degradation

Off-road vehicle (ORV) recreation has become a very popular form of outdoor activity and is one of the most serious public land-use problems in the United States today (Sheridan, 1979). Motorized recreation has long been a problem in American deserts (Wilshire et al., 1978), resulting in severe degradation of a very fragile and long-to-recover ecosystem. Only recently have park managers and administrators recognized the magnitude of this impact in coastal areas. There has been little research on this subject, except for the fine work of Liddle and Greig-Smith (1975) in Great Britain. Australian beaches and dunes experience heavy vehicular impact (Fabos, pers. comm.), but research there is just now being initiated.

This article serves to summarize our research findings and conclusions drawn from a multifaceted, experimental analysis of off-road vehicle impacts in Cape Cod National Seashore, Massachusetts. Various ecosystems susceptible to ORV traffic were impacted in a controlled fashion so that rates of deterioration and recovery could be measured. The environments tested (beach, dunes, salt marshes and tidal flats—see Fig. 1), will be separately described in the following sections since problems encountered reflect inherent characteristics of each zone. Although vegetation type varies considerably on a regional, as well as global basis, it is fairly safe to assume that the conclusions from this study can be generally applied to barrier beaches anywhere. However, scientific data should be gathered for each individual region and examined in detail for proper tailoring of the management program.

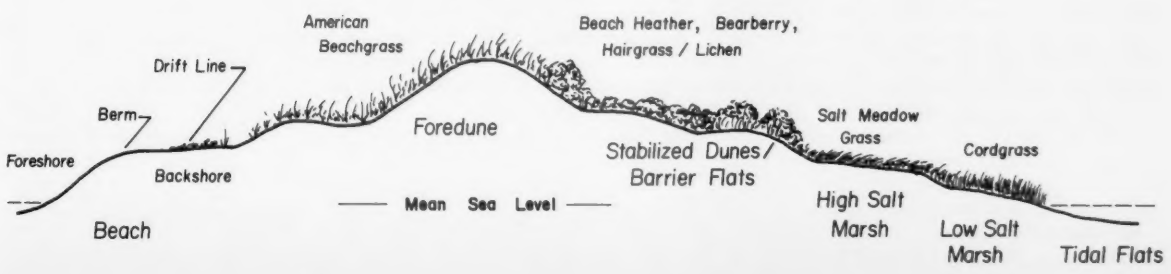


Fig. 1. Idealized cross-section of a barrier beach, illustrating the environments subject to ORV impact (not to scale).

Beaches

The intertidal ocean beach appears to be the most naturally variable and therefore the most resistant to long-term vehicle impact. Continuous change from sand transport during tidal cycles, as well as annual and storm-induced beach cycles, made analysis of ORV impacts very difficult. There were very few marine invertebrate organisms on this northern beach, so that vehicular impacts were minimal in this respect. However, it should be noted that southerly beaches have larger and more diverse populations of marine animals living under the sand surface, such as ghost crabs, that are directly and severely affected by vehicle passage (Steiner and Leatherman, 1980).

Impacts on the high beach or berm were more clear-cut than on the intertidal beach face. The high beach area is very heavily impacted, being a relatively flat surface influenced only by the highest tides. It is here that drift accumulates, sea birds nest, and new dunes form along accreting beaches. On some stretches of beach the most characteristic single trait of the backshore is massive, washboard ruts (Fig. 2). Vehicle passage increases surface roughness, which can lead to greater beach variability and increased transport of sand by wind. It was also noted that vehicular passage breaks the (salt) crust, when present, which can initiate sand movement by the wind. With an offshore wind, this sand can be blown toward the ocean and lost to the longshore current system (Anders and Leatherman, 1980).

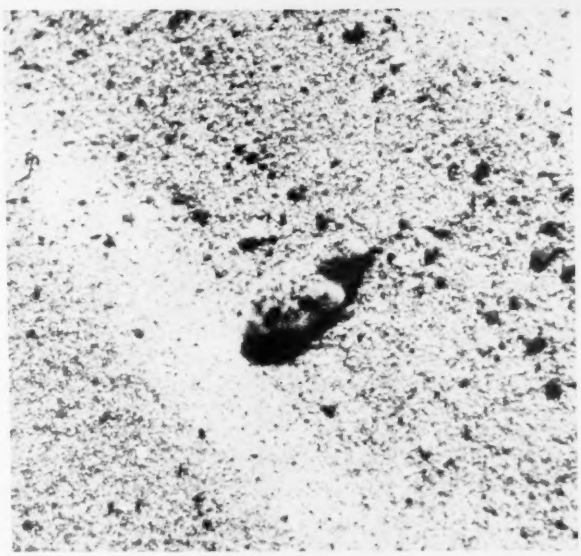
The part of the beach most sensitive to ORV impacts is the drift-line zone, which consists chiefly of organic material deposited on the backshore during high spring tides or storms. Drift lines on northern beaches contain large quantities of marine algae, eelgrass, and marsh detritus. Bacteria and fungi quickly break down this organic matter, releasing nutrients into the sand and eventually back to the sea. The drift-line zone also contains fragments and seeds of dune plants and is therefore a significant site for new dune development on open sand. Regeneration of American beach grass (*Ammophila breviligulata*) on a bare sand beach is almost exclusively by growth of plant fragments washed from eroding dunes and redeposited on the beach as drift. Once the plants are established, embryonic dunes can develop, provided they are not destroyed by storms or ORV impact.

The shearing and compressional effects of ORV passage extend to a depth of approximately 20 cm; the shear stresses of the turning wheels disaggregate the drift and break underground plant stems known as rhizomes (Zaremba et al., 1978). The integrity of drift lines is destroyed by ORV traffic as the material is scattered about the beach. Vehicle impact also decreases the rate of decay of organic material. Bacterial counts associated with the drift were normally very high but were markedly reduced when vehicles pulverized the organic deposits. Vehicle traffic also crushes and kills seeds of annuals and the young plants of perennials, such as *Ammophila,* which are associated with the drift. It was found that the effect of 100 passes of an ORV does not differ significantly from that of 10 passes; only a few passes are required to break up the deposit and kill all the vegetation. Thus, the major effect of vehicles in the beach zone was on drift lines and developing dunes, with traffic severely limiting new dune formation.

The impact of ORVs on colonial beach-nesting seabirds, specifically Least Terns *(Sterna albifrons),* and on transient populations of other migratory shorebirds was studied by Blodget (1978). Where there are nesting sites on narrow beaches, direct confrontations between vehicles and birds are likely to result, and the birds will suffer accordingly. Drivers passing directly through a colony (either accidentally or intentionally) will run over eggs and chicks. However, as long as birds have room to nest and are protected, and as long as drivers have space to pass by the colonies, the two uses of the beach can coexist. With complete closure of nesting areas and wardening, hatchability of Least Tern eggs remains excellent, despite proximate ORV traffic. Without this positive management approach, the highly camouflaged nests and young of beach-nesting seabirds, particularly terns, render them particularly vulnerable to disruption during the nesting season (Fig. 3).

Fig. 2. Vehicles leave their mark on the beach long after their passage.

Fig. 3. Least Tern chicks will sometimes hide in vehicle tracks for protection. Their coloration and size makes them nearly impossible for ORV drivers to detect.



Specific management recommendations for beach areas are as follows:

1. *ORV use should be restricted, whenever possible, to the outer ocean beach, seaward of the drift-line zone and expanding dune edge.* Such areas are subject to the greatest environmental change due to natural causes and are therefore less likely to be permanently damaged by ORV use. Also, if damage does occur, recovery would be most rapid in this area. However, other factors must also be considered with regard to use of the outer beach, such as conflicts with pedestrians, swimmers, foraging or resting shorebirds, and marine life within the sand beach.

2. *Prohibit driving in the upper backshore area, particularly in the areas of drift.* These drift lines are the precursors of new sand dunes on accreting beaches and can also moderate the rates of erosion when new vegetation is established at the base of a dune scarp.

3. *Close beaches that are so narrow as to force drivers to run along the very edge of the dunes at high tide*. Provide adequate bypass routes around such areas, if access is deemed necessary.

4. *Close beaches to vehicles during periods of exceptionally high tides, which force drivers to travel along the face of dunes or through shorebird nesting sites and embryonic dunes*. This can be an important safety measure, and it can serve to protect the leading edge of the dunes and prevent damage to shorebird colonies. Access points to the beach should be closed at these times and posted accordingly.

5. *Nesting areas of Least Terns and other shore and waterbirds must be protected by (a) fencing, (b) posted signs, (c) restriction of beach traffic to marked tracks, and (d) strict enforcement of leash laws for pets*. Interpretive signs should be placed at beach route entrances to (a) alert drivers to watch for active colonies, (b) explain briefly the biology of the birds, and (c) request visitor cooperation in protecting them. Signs calling attention to the colonies themselves should be posted at least 100 feet on either side, urging visitors not to approach any closer. Vehicles can pass by somewhat more closely if they do not stop, but people getting out of their vehicles will scare the birds, which can lead to nesting failures. Dogs in particular must be kept from the nesting areas since the birds are much more alarmed by dogs than even by people approaching on foot.

Dunes

The effects of vehicles on dunes depends on the specific area impacted. Where American beach grass (*Ammophila*) is expanding directly onto the beach, fewer than 50 passes can stop seaward growth and development of the foredune system (Brodhead and Godfrey, 1979a). This low-level impact is enough to set back *Ammophila* expansion by a full year. Driving along the front of an advancing *Ammophila* community will effectively stop new growth, and continuous ORV impact along a foredune front can induce or accelerate erosion and dune scarping. Such traffic will also prevent the healing of erosion scarps by interfering with the natural tendency of *Ammophila* to invade and colonize open sand.

The effects of experimental ORV impacts on *Ammophila* vegetation along a straight section of track showed that relatively low levels of impact (less than 175 passes) were sufficient to create maximum damage to the plants (Fig. 4). The experimental data clearly indicated that the first passes of a vehicle across the dune grass community were the most critical and damaging. In this sense, *Ammophila* vegetation does not have a "carrying capacity" for vehicles. There is also no intrinsic difference between tolerance of *Ammophila* plants on the foredune and backdune: all sites are affected to nearly the same degree. An open track will soon result from repeated passes of vehicles, and an established ORV dune track can be considered a rather permanent feature.

Studies by Brodhead and Godfrey (1979a) also showed that there were no differences in recovery rates between sites that received heavy impacts (675 passes) and those that received moderate impact (270 passes). Thus, the rate of recovery following relatively few vehicle passes is about the same as after heavy impacts. Once started, a vehicle track will remain open and bare with minimal use.

Recolonization proceeds according to the overall vigor of the vegetation. Near the beach and in the foredune, where growing conditions are most favorable, complete recovery can occur within four years. Recovery on the backdune, where growing conditions are less favorable, takes much longer. After four years of protection, experimental ORV tracks are still visible in this study plot. Other studies have shown that ORV tracks in backdune areas are clearly visible even after eight years of protection. Thus, ORV effects are longest lasting farthest from the source of new sand that promotes optimal growth of *Ammophila*. Natural regrowth can be set back easily by passage of a few vehicles. Management actions, such as fencing and replanting, are necessary to rehabilitate badly damaged sites.

The orientation of planned or illegal vehicle tracks is very important to the future of any dune field. It is preferable to orient trails parallel or diagonal to dune contours rather than perpendicular to them in order to minimize sand transport. Tracks should **not** be established along the

Fig 4. The foredunes and backdunes were experimentally impacted until all the vegetation was killed, and then recovery was monitored for four years. This oblique photo shows the Race Point "race track" where these impacts were applied.

Fig. 5. Many open slopes and migrating dunes, now very much in evidence throughout the Province Lands, owe their present condition, if not their origin, to the continued use by off-road vehicles, particularly the illegal and occasional dune-busters.

direction of prevailing winds, which are from the northwest in our study area. Bare tracks exposed to strong winds will develop into blowouts (Fig. 5), increasing erosional problems and encouraging dune migration. Unvegetated sand dunes will continue migrating across stable areas as long as traffic is permitted across the crest and high-angled slopes.

Tests made on other types of stabilized dune vegetation showed that no one species has a greater capacity to withstand ORV impacts than another. Plant communities dominated by *Arctostaphylos uva-ursi* (bearberry), *Deschampsia caespitosa/Cladonia* (hairgrass/lichen), and *Hudsonia tomentosa* (beach heather) commonly develop on stabilized dunes and are subject to ORV damage. Each vegetation type broke down at approximately the same rate when compared to *Ammophila* dune vegetation; the first passes (50 or so) were sufficient to create maximum damage (Brodhead and Godfrey, 1979a).

Rates of plant recovery, however, were different, and the various communities can be ranked according to regrowth capacity. *Arctostaphylos* and *Deschampsia* showed moderately fast recovery; the communities were returning to pre-impact levels within four years. *Arctostaphylos* showed the most rapid recovery since its hard, woody, creeping stems were not severely damaged by the level of impact experimentally applied. New stems could be produced in a relatively short time, but the tire tracks in the sand are still evident. However, these tests were made on level surfaces, and similar damage on slopes would likely have led to long-lasting erosional problems.

Fig. 6. Beach heather (Hudsonia) *was especially sensitive to impact, and there were few signs of recovery after three seasons of monitoring.*

The most sensitive community in terms of recovery time was *Hudsonia*. Due to its growth habit—short, dense, and shrublike—*Hudsonia* was quickly destroyed by ORV impact. Since the plant does not spread readily by underground rhizomes or aboveground creeping stolons (stems), much more time is required for revegetation, which is accomplished primarily by seedlings in the tracks. After four years of monitoring, ORV tracks in the *Hudsonia* (heathland) community were clearly visible and largely bare (Fig. 6). Such damage, particularly on easily erodible sand, can lead to blowouts, since the area remains open for long periods of time. It is therefore imperative that all off-road vehicle traffic through heathland communities of *Hudsonia* be prohibited.

In summary, off-road vehicles have substantial effects on dune vegetation, which can lead to degradation of the dune system. Maximum damage to vegetation results during the first few passes of a vehicle. Dune vegetation has a low threshold of tolerance, and only 100 passes are sufficient to cause severe degradation. Given protection, however, the vegetation on dunes will recover, but at varying rates, depending on the species and environmental conditions. Vehicle use must be controlled and managed to avoid ever-growing damage to dunes and dune vegetation. Continuous use of open dune regions by vehicles, particularly those that stray from marked trails, results in dune erosion and migration. Specific management recommendations follow.

1. *Prevent vehicle entry into previously closed dune regions.* Whenever possible, provide public transportation to inaccessible areas or allow only walk-in use.

2. *Where ORV access is necessary, tracks should be carefully planned to avoid the most sensitive areas.* These include:
   a. drift lines and embryonic dune areas;
   b. the leading edges of expanding dunes;
   c. older, stable dune areas where drivers would be inclined to leave the tracks;
   d. heathlands and hairgrass/lichen communities—particularly beach heather (*Hudsonia*).

3. *Wooden ramps should be built and maintained over dune lines, providing beach access through the dune zone.* Such ramps are most critical where lowering of the dune line might lead to greater storm

Fig. 7. ORV passage through the low salt marsh compressed the peat, reducing it to a quagmire.

hazards for habitats or facilities behind the dune. New routes over dunes to the beach should not be allowed when adequate ramps already exist.

4. *Dune routes should be oriented in such a way that prevailing winds cannot create blowouts.* Specifically, open trails should not face the prevailing winds. Properly placed borders of vegetation can help to prevent wind erosion.

5. *Dune routes should be designed to avoid sharp turns or climbs up steep grades.* Otherwise, drivers are likely to make new, unofficial trails that are easier to negotiate but which tend to increase the total area being impacted.

6. *Restrict traffic to marked routes with borders of cable or dense, impenetrable shrubs.* Such tracks should be established only after careful study, to avoid or minimize environmental impact. Most trails should be permanently closed, and only those absolutely necessary should be retained.

7. *Vehicle trails must be controlled and maintained.* Deterioration of the track (especially washboarding) often spurs drivers to leave the established trails and impact the surrounding vegetation.

8. *Close off deteriorated dune routes and institute management programs to repair the damage, especially where natural regrowth would be slow.* Most dune species can be readily transplanted, and thus vegetation can be restored.

9. *Close all sensitive habitats such as heathlands and shrublands.* Habitats with slow-growing species that experience stress due to drought and lack of nutrients are likely to be the most severely damaged, and must be protected from vehicle passage.

10. *Institute interpretive programs and displays that are aimed at educating the public to ORV damage.* People need to be made aware that "dune-busting" and "wheeling" are extremely damaging to dune systems, and severe penalties for such activities should be instituted. When shown the reasons behind ORV regulations, most people will accept them.

11. *The concept of "no carrying capacity" should be emphasized when planning for ORV use.* A few vehicle passes through dune vegetation can create substantial problems, and once a trail is open for use, there is little difference between very light and very heavy use. For this reason, establishing a few, well-managed, "heavy-use" trails is preferable to many "low-use" trails.

12. *Whenever possible, ORV use should be restricted or eliminated entirely in the dunes.* In general, ORV use in these areas is not compatible with the natural processes and adaptations of organisms to this environment.

Salt Marshes and Tidal Flats

Of all the ecosystems studied, intertidal salt marshes and sand flats were the most severely affected by vehicle impacts. This environment harbors a variety of marine and coastal organisms and supplies the primary productivity to the estuarine and nearshore marine food webs. The complex food webs, leading to the great diversity of marine life, are dependent on the proper functioning of the intertidal ecosystem, and vehicles can significantly affect this ecosystem. Dune environments are also seriously affected by ORVs, but the complexity of those habitats does not compare with the intertidal zone of marshes and flats. Thus, dunes are more easily managed and repaired than intertidal areas.

ORV impacts in the high salt marsh, dominated by *Spartina patens* (salt meadow grass), can be substantial, but this zone is not extensively used for driving. Less than 200 passes killed the standing biomass, and three seasons were required for recovery (Brodhead and Godfrey, 1979b).

Although the low salt marsh of *Spartina alterniflora* (cordgrass) is rarely impacted, destruction by a vehicle can be very severe and long lasting. **Only one pass of a vehicle is sufficient to create ruts in the marsh peat that will persist for quite a long time; the marsh surface can be depressed by 10 cm or more.** Thus, the major effect of traffic through marsh peat is to create deep ruts in the soft organic substrate. Only 90 passes of a Jeep were possible in the experimental impacts because compaction of the peat created an impassable quagmire (Fig. 7). The vegetation in the tracks was totally destroyed, creating a series of depressions in the peat. These undrained depressions accumulated and retained salt water during each high tide. As evaporation proceeded, the salt content increased and reached levels that were too high for most plants to tolerate. Artificial pannes precluded reinvasion by marsh plants and provided habitat for salt marsh mosquito larvae. The creation of these vehicle-induced depressions in the low marsh thus altered the environment to the detriment of the marsh system. On our own study site such ruts were clearly evident after four years.

One of the most seriously affected regions in the intertidal environment is the upper sand flats, which provide the surface on which new salt marshes form. Although some extent of flats is natural, the extensive sand flats in the study area were artificially maintained by ORV traffic (Fig. 8). Once protected from such impacts, the sand flats were quickly colonized by low salt marsh species, in particular *Salicornia* spp. (glasswort). Invasion by *Spartina alterniflora* (salt marsh cordgrass) took longer but was nevertheless underway in a relatively short time (i.e. two or three years). From these exclosure experiments, it became clear that

Fig. 8. Some ORV enthusiasts will actually drive through salt water on the tidal flats. This type of trespass kills shellfish and other marine organisms, with severe consequences to the intertidal ecosystem.

the present level of vehicle use on certain sections of the flats was preventing the natural development of salt marshes.

ORV traffic on the naturally open flats has also affected the survival of marine organisms, including worms, clams, and other mollusks (Wheeler, 1979). Counts of marine animals in transects across driven and nondriven sections showed marked reductions in the driven zones, which implies that "normal" ORV activity does deplete population numbers and might be sufficient to eliminate these species in impacted areas.

Marine worms were greatly affected by low levels of ORV impact. After the application of 50 passes per day during a 20-day test, the polychaete (clam worm) populations were totally decimated. This result is not surprising since they are soft-bodied organisms and are therefore particularly susceptible to physical compression. Depletion of numbers of polychaetes would discourage shorebirds and fish from feeding in the area, and decrease the amount of organic material supplied to the food web.

Experimental tests were made on the survival of soft-shell clams (*Mya arenaria*) under relatively low levels of vehicle impact. The 20-day period of impacting marked clams (*Mya*) 50 times per day resulted in total elimination of experimental animals and established that the clam population could easily be depleted by vehicular traffic (Wheeler, 1979). Clams were killed by the crushing of their relatively soft shells, as well as by modification of the environment. Vehicles compacted the substrate to a pavementlike (macadam) surface, interfering with normal exchange of sea water with the sediments and creating anaerobic conditions in the substrate. Compaction also prevented clams from extending their siphons to the surface to obtain food and water at high tide; such restriction eventually results in death to filter-feeding organisms such as clams.

The results of this study imply that ORV activity in the intertidal zone has adverse effects not only at the species level, but at the ecosystem level as well. Any natural system that has been disturbed by humans may lose important species, food-web complexity, and much of its aesthetic and recreational appeal. Continued ORV disturbance can create biologically unproductive as well as aesthetically unappealing, barren areas.

In summary, it was found that only a few passes of a vehicle in the salt marsh/tidal flat area were sufficient to cause maximum damage. The amount of controlled impacting was much less than normally experienced by a recreational area on a typical summer day. *Salicornia* plants were destroyed by only 1 to 5 passes; *Spartina alterniflora* by 90 or less; and *Spartina patens* by less than 200. With protection, recovery begins almost immediately. Full colonization of a barren flat by *Salicornia* occurs in two years, with *Spartina alterniflora* increasing significantly in that period as well. The low *Spartina alterniflora* marsh was severely affected by ORV impact, which produced deep ruts in the peat substrate. The ruts remained after four years, although vegetative recovery was nearly total in that time. The high *Spartina patens* marsh showed the lowest ability to recover following total destruction; it may require decades of protection for normal conditions to return.

Management recommendations for salt marshes and tidal flats must be directed toward total exclosure.

1. *Close all salt marsh and tidal habitats to vehicle use.* The system is much too sensitive for such recreational purposes; it has no carrying capacity for vehicles. ORVs are a major stress to this environment, detrimental in all aspects, and it is clear that vehicles should be excluded from such environments. Once closed, the salt marsh/tidal flat system will begin to recover, but it must be patrolled and regulations enforced. Only a few illegal passes through protected areas will substantially set back recovery of vegetation.

2. *Prevent traffic from using the border zone between salt marshes and dunes.* Provision should be made for bypassing the marshes and flats by developing a series of carefully located upland trails.

3. *Establish a series of interpretive displays that show how vehicles damage marine resources.* Such information can help visitors understand why these areas must be closed.

Conclusions

Several general conclusions can be drawn from this research. It appears that as environmental stability of certain portions of the coastal ecosystem increases, their sensitivity to ORV stress also increases. Thus, more stable parts are more likely to be damaged by vehicle impacts. Those environments that undergo the greatest natural physical changes, such as the intertidal ocean beach, appear to have the greatest tolerance to vehicles. Although vegetation is adapted to the severe physical stresses of moving sand, high winds, salt spray, and dessication, it cannot tolerate continuous mechanized pressures. Although rapidly growing beach grass (*Ammophila*) recovers quickly after impacts where conditions are favorable, it can be totally destroyed by continuous, low-level ORV pressure.

At least until further research shows otherwise, the best place for vehicles to travel is the open **intertidal** ocean beach, as long as access to this area does not interfere with shorebird nesting areas, embryonic dune regions, or zones with major populations of marine animals. Other than the intertidal beach, the only place for vehicles to travel, where environmental impact can be kept to a minimum, is through the dunes along specifically marked and well-maintained trails with a minimum of steep grades or sharp turns. Sand transport down dune slopes can become a problem when heavy traffic is allowed to follow the same paths for a long period; dune areas can be lowered and also rendered more unstable by indiscriminate traffic. When such trails must be closed, revegetation can be promoted by fertilization or planting projects.

Those upland sites that have been stable for some time and support heathland or low shrub vegetation are the most easily damaged. *Hudsonia* (beach heather) vegetation was particularly susceptible to impact and took the longest time to recover. Every attempt should be made to prevent vehicle travel across these communities.

Intertidal salt marshes and sand flats are also very sensitive to vehicle damage. Traffic in the low marsh will create deep, long-lasting ruts, leading to artificial pannes. On the high marsh, excessive traffic will damage the vegetation and also lead to open flats and sand channels. All salt marshes should be closed to vehicle traffic.

Sand flats are important precursors of new salt marshes. Where vehicles are allowed to travel, marsh expansion onto the flats will be inhibited. Those open areas beyond the limit of salt marshes are important habitats for marine organisms, particularly worms, clams, and other mollusks. Vehicle traffic, even at relatively low levels, compacts the substrate into a pavementlike surface and reduces survival of these organisms. Tire pressure on the sand surface can also directly kill the animals living in the sediment, especially soft-bodied creatures and soft-shell clams. Sand flats, along with marshes, are therefore especially sensitive to vehicle damage and should be completely protected.

The best way to avoid problems with vehicles is to prevent their entry into previously closed regions. Wherever possible, provide public transportation to inaccessible areas. A series of interpretive displays should be used to show how vehicles damage the environment. Such information can help visitors understand why certain areas should be closed or controlled. The public is much more likely to be cooperative if they understand that these policies are in their best interest.

The best general management approach is to maintain a conservative program regarding vehicle use. Management plans should be based on sound scientific information whenever possible. When such data are lacking, the ORV plan should err, if it must, on the conservative side. Maintaining the critical balance between public use of coastal recreation areas and protection of the resources requires that all sections of the interested public be involved. This is a very difficult task, but one that can be accomplished with the help of basic data and public understanding of that information.

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Hamady Sow

Educational Program in Senegal Parks

To educate, to promote better understanding, love and protection of nature is a primary concern of the Republic of Senegal's National Parks Management division.

For efficient protection of nature, sustained action in sensitizing, informing and educating the Senegalese population is necessary. Certainly environment cannot be conceived without man, but man will not be able to survive if there is destruction of his natural setting. Sensitizing, informing and educating the people of today, but above all the children who will be making decisions tomorrow, assuredly is the way our natural environment will be best known, best loved and therefore best conserved and protected.

Education relative to the conservation of nature and the protection of the environment in our country has been off to a good start since 1977. It was, in fact, in that same year that the World Wildlife Fund (WWF) endowed the National Parks of Senegal with a fully equipped audiovisual unit having an estimated value of about two million CFA francs. Obtaining this new material was concurrent with the creation of an education office managed by a training staff from the National Parks Service.

At the outset of the project in 1977 the head of the effort was assisted by an American Peace Corps volunteer on a two-year assignment.

Mobile audiovisual centre, developed and supplied by the World Wildlife Fund, is used to give five or six conservation education programs each week in population centres throughout Senegal. These showings are very popular. "Our arrival in a village is cause for a sort of festival," the author reports.

Assistance was received from the WWF which granted the National Parks the mobile unit needed. The details of the equipment were published in PARKS, Volume 1(4) in 1977.

The mobile unit was based on a small Renault van designed and equipped as a mobile audiovisual centre. It contains film and slide projection equipment, sound and recording equipment, screens, a generator and other equipment.

The vehicle and its team are assigned to a park for one year during which they travel about, going to nearby villages to explain to people living in the vicinity the park's reason for being and its short-term and long-term impact on the villagers.

How a Showing Goes

A film showing can occur in the village, in a section of a city, in a school or in any central gathering place. Thus it can be focused on a variety of audiences. In a village the showing usually is for a mixed audience. Distinctions as to education, age and sex are kept at a minimum in this case.

Generally the audiences are illiterate, and local languages are used: Poular, Mandingue, Ouolof, etc.

The program can be simplified according to the listeners but can still retain its documentary importance. The subjects of conservation and the protection-of-nature topics usually include:

— The struggle against poaching
— Brush fires
— Limiting overcultivation.

These topics are illustrated by suitable programs of slides and films.

The projections take place at night in the villages. The center villages are the first ones that are chosen. A meeting between the audiovisual unit team and the influential villagers precedes the projection session. These meetings often take place in the evening in the home of the village chief or in the public square. The general objectives are discussed as well as the selected topic. This is an introduction of sorts.

After the projection, which is commented upon in local languages, the public is invited to make its opinion known, with no discrimination as to age or sex. The next day the audiovisual team conducts an inquiry about the interest aroused by the showing and the people's attentiveness.

Seats are prepared for a small group to watch slides on the screen in the rear of the vehicle. Photo: A. R. Dupuy

In areas which can be reached by the unit's vehicle each village can expect two visits a year from the audiovisual team, and each time we spend two days in each village. The pace is from five to six showings a week in the villages and three to four in the large centers. In the village an audience of anywhere from 50 to 300 people can be expected. The population is very enthusiastic about our visits. Our arrival in a village is cause for a sort of festival. Men and women are eager to discover their natural heritage, of which actually they are often unaware. First it is the entertainment side that wins out. But serious thinking about the matter is not long in coming. That is how the villagers answer our questions on the thought process and ask us others.

All the same, even though education may be a complex and arduous task, its objective being first of all to bring about a change in the outlook and attitude of the interested public, we can reasonably expect some positive results a few years from now, considering the interest that the people are showing in our visits among them.

During this past March we recorded several invitations from village chiefs and the presidents of rural communities.

This educational mission by means of pictures in the outlying regions is completed by television broadcasts in Dakar. They are very successful where the public is concerened, if one may judge by the mail received and the requests from young secondary school students to create youth nature clubs.

An exhibit on "accelerated elephant poaching" was carried out in Dakar with the showing of films and slides. This one-month exhibit in the capital will then move on to regional capitals. Finally, seminars bringing together teachers and various public figures have been organized, under the auspices of UNESCO, to sensitize everyone concerning the serious protection problem.

Operators preparing for an evening showing of slides. Audiences of local peoples are keenly interested.

Simple documents in French and vernacular languages are published and distributed free of charge to rural schools. Included are "Nature and Man," a small green book on national parks, a tract on the death of the old elephant, posters and so on.

To conclude, the growth of youth nature clubs throughout the country is definite encouragement to go on with our "education" action in the area of protection. It shows that young people are becoming conscious of their environment and the fact that it is absolutely necessary to protect it, whatever the cost.

Hamady Sow is Chief of the Office of Education in Senegal's National Parks Service, and is in charge of the mobile education project. Previously he served as a conservator in several national parks, including Niokolo-Koba.

Thomas E. Lovejoy

Discontinuous Wilderness: Minimum Areas for Conservation

Most if not all the remaining opportunities to establish national parks and similar protected natural areas will occur in the final two decades of this century, particularly during the decade already underway. Soaring human population growth and dwindling biological resources inevitably will generate increasing pressure on remaining wild lands for conversion to agriculture and like uses, despite their marginal nature. It is an exciting time to be working in conservation because so much can be saved and so much can be lost.

One of the major differences affecting design and management of national parks today, in contrast to Theodore Roosevelt's time when a park was likely to be part of continuous wilderness, is that there is considerably more likelihood a national park will be an isolated fragment of the once continuous habitat. The isolation of that fragment is of considerable importance in that the biological community in question will be deprived in many instances of animals and plants which normally disperse widely and frequently in continuous habitat. Not all species of animals and plants will necessarily be so affected, for some are champion dispersers regardless of habitat, but it is a large problem to be dealt with in national park design and relates to the fundamental design question: How large?

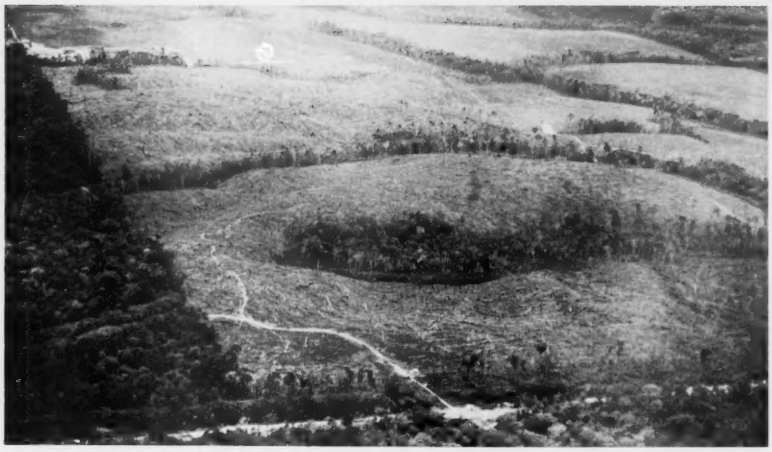
Naturalists have been aware since the 1830s that the larger the area involved the greater the number of species it would contain. This taken just by itself does not help all that much, for the option of including all the land of the planet in one gigantic biosphere reserve or park simply does not exist. It does however imply that no matter what size an isolated habitat fragment might be it is likely to lose some species after isolation. This is because, whatever the size, some of the species included will be represented only by single individuals or population units too small or inappropriate in age structure to be reproductively viable over the long term.

That is basically the status of the problem as it is now known. Isolated habitat fragments are known to lose species after isolation, but at rates and by processes largely unknown. The process might be thought of as decay of an ecosystem, rather as radioactive minerals lose minute particles in decaying to new lower and more stable states. If care is not taken to understand this problem of species loss from habitat fragments, many species, the protection of which had been considered taken care of, may be lost, and many parks and reserves will end up being less than they were intended to be.

To date much of the effort to investigate this species loss problem has been based on islands. Land bridge islands (those once continuous with continental mainlands) generally have more species than oceanic islands of similar size, but fewer species than areas of similar size on the mainland. This is presumably because the land bridge islands have lost some of the species they originally contained at the moment they were isolated by rising sea levels, when they were equivalent in species richness to the mainland. Presumably too, the land bridge islands have not had time to lose all of the species they are destined to if they are ultimately to reach an equilibrium number approximately that of similarly sized oceanic islands. Much of such analyses has been closely tied to the theory of island biogeography, a theory which is particularly attractive in this instance because it includes the dispersal problem: the theory asserts that the number of species on an island is a consequence of both extinction rate (loss of species from the islands) and immigration rate (dispersal to the island).

It has been difficult to take this approach to the problem very far mainly because it is hard to make tight statements and comparisons about which species actually existed on islands at the moment of isolation. Similar kinds of problems arise when comparing censuses of remnant forest patches; in all too many instances the initial species compositions of the forest patches have to be assumed. Were it not for the propensity of the bird watching public to make censuses, often there would be no information about such forest patches other than present day enumerations, and the analyses would be all that much more shaky. Nonetheless the sorts of analyses which are being made on forest patches in the vicinity of Washington, D.C., in the New Jersey piedmont, and by Britain's Nature Conservancy Council are worthwhile efforts to gain some insight into the problem and processes.

1. Various groups of plants and animals are being studied by Brazilian and American biologists in undisturbed forest areas which will be fragmented by clearing to provide baseline data against which the effects of that forest clearing, and the effects of species interaction subsequent to the isolation caused by clearing, can be compared. This research program, with international support, is expected to run for 20 years or more and provide answers to many questions about the rates and processes of species loss and ecosystem decay.



Probably the best known situation is that of Barro Colorado Island, a Panamanian hilltop gradually made an island in 1910-1914 by the rising waters of Lake Gatun, created for the Panama Canal. Although the avifauna was not tabulated prior to isolation, the island was censused soon after and at a number of intervals subsequently. By 1970, 45 species of breeding birds, about 22 percent of the original census, were gone. Edwin O. Willis, in analyzing this situation, distinguished between species lost as the island's second growth forest matured and those presumably lost because the island's 15.6 square kilometers were simply insufficient to support them. The number lost from the area effect was determined to be 13—very close to the number which was predicted from studies based on island biogeographic theory. Lacking even in this situation is sufficiently continuous study of the bird populations over the half century involved to gain real understanding of the problems encountered by these species. It is interesting that when experimentally reintroduced by Eugene S. Morton, a species of wren supposedly lost because of the area effect immediately took up residence in one of the few remaining areas of second growth on the island.

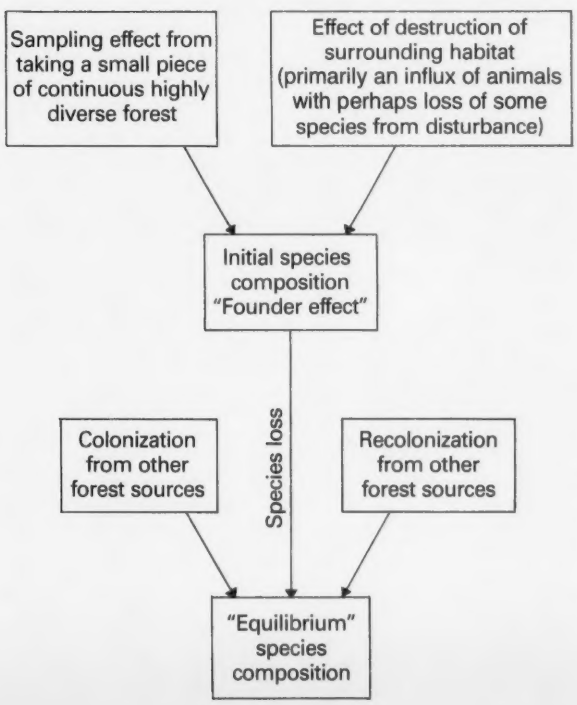
Clearly a major research attack on this problem of attrition of species from habitat fragments is needed if the charge to protect a representative series of the world's ecosystems and their species is ever to be responsibly met. One effort to do so is currently being undertaken as a joint Brazilian-American enterprise two hours' drive by field vehicle north of Manaus in the Brazilian Amazon. There the local authorities have agreed to help this effort conducted by the World Wildlife Fund and Brazil's National Institute for Research on Amazonia (Instituto Nacional de Pesquisas da Amazonia = INPA). The geometry of land areas which local cattle raisers are required by law to leave in forest is being adjusted to provide a series of forest patches varying in size from one hectare to the 7,500-10,000 ha range. There will be replicates in almost all size classes in order to gain a measure of how predictable is the order in which species might be lost and how similar is final species composition and number for a given size of forest patch. Currently Brazilian and American biologists are studying in still continuous forest in plots marked off for protection when forest clearing takes place. The forest is remarkably undisturbed at this point prior to fragmentation and includes large mammals such as jaguar, puma, giant anteater and tapir. In a large tree in the buffer zone around one of the one-hectare plots a pair of crested eagles, second only to the harpy in size in South America, is nesting. How well the pair will be able to manage when the forest is fragmented is part of the problem to be studied. Various groups of plants and animals are being inventoried in the study areas to provide baseline data against which the effects of clearing and the effects of species interactions subsequent to isolation can be compared (Fig.1). It is a major undertaking which may run for 20 years or more, and which so far the U.S. National Park Service, the Man and the Biosphere Program with support from the Agency for International Development, and a private foundation have helped to launch.

These forests are particularly good for such a study in that the amount of geographic relief is small so that large differences in species composition are not introduced by altitudinal gradients. Also, almost none of the animals, including the birds, are migratory, so there is no problem of dealing with possible effects from the time when individuals would be

2. In northern Brazil, where forested areas are being cleared for use as cattle ranches, patches of forest from 1 hectare up to 10,000 ha will be left standing. These patches and replicates, in all size classes, are being studied for species loss data.

3. Forests ecosystems are rich in numbers and varieties of species and many interactions depend on this richness. For example, Brazil nut trees (Bertholletia excelsa) *are pollinated by a single species of bee. When this tree is not in flower the bees must find other flowering tree species as a source of nectar, or perish.*

History of a Forest Fragment


Sampling effect from taking a small piece of continuous highly diverse forest
Effect of destruction of surrounding habitat (primarily an influx of animals with perhaps loss of some species from disturbance)
Initial species composition "Founder effect"
Species loss
Colonization from other forest sources
Recolonization from other forest sources
"Equilibrium" species composition

absent. In addition, species loss from interdepending species complexes will be clearly pronounced because of the high frequency of interlocking biologies of species in these forests. One interesting example to be examined is that of how many colonies of army ants are necessary so that enough colonies are in swarm on any given day to provide support for the bird species which habitually follow the colonies and live by snitching the ants' prey as they flee before the swarms. Another interesting sort of question will involve the area necessary for the number of trees of different species necessary to support all year long a pollinator such as the only bee capable of pollinating the Brasil nut.

A great deal of basic information about these forests as well as information about the effects of fragmentation will emerge from these efforts. One would only wish that such information was *already* available to aid the nations of the Amazon basin in the design and management of national parks. Some information will emerge relatively rapidly, however (which is why some really small patches are included). Also, it should be possible to hedge on the question of size by bordering national parks with watershed forests or forests of other purposes so that boundary increases can be made if necessary later on.

It is hoped that the project will yield generalities about park size and management techniques to reduce the species loss problem that could be useful around the world. It is nonetheless true that each ecosystem and each geographical region is likely to have its own ecological peculiarities and own particular minimum size to reduce shedding of species. Consequently it would be very desirable if similar sorts of research programs could be initiated in other areas of the World. Even in ones where most if not all choice of national parks has already been made, the chance to study species loss can aid in better management.

It is important to remember that the notion of minimum size, while important conceptually, is likely, in the dynamics of the real biological world, to produce only an approximate fuzzy measure of minimum size for a given ecosystem. It may never be possible to know what is the minimum area necessary for a minimum population of a top predator in an ecosystem; in the last analysis reintroduction programs of top predators may perforce become the only solution to a problem that is somewhat intractable to study. It is critical to keep in mind that the ultimate goal is to protect ecosystems at as close as possible to their original and characteristic diversity: both today and a millenium hence, a given forest reserve should have the same number of tree and other species per unit area.

Also it is important to bear in mind that the goal of conservation is not only to protect fauna and flora, but to protect it in representative ecosystems as close as possible to those which occurred naturally when wild habitats were generally continuous around the globe. This protects both ecosystem structures and ecological processes which are also of great value in the management of the biosphere in support of people. Sometimes, for political or other reasons, those processes can only be protected in small reserves which should not be scorned; small can be beautiful in fulfilling the goals of conservation too. Also, it should not be forgotten that all biological systems, including ecosystems, are dynamic, and that an equilibrium endpoint for a forest fragment, whether at natural equilibrium or at a more species-rich managed equilibrium, is subject to change. Species composition is likely to change a bit from arrival of species good at dispersing; the management of a reserve must consciously take this into account.

There is a lot to be learned about ecosystems by studying their decay and partial disintegration. One can well rue the need to study ecosystems as they fall apart, but more and better conservation should result.

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PARK TECHNIQUES

Guidelines for the Preservation of Sound Recordings *Dan Riss*

Introduction

More and more parks have custody of valuable historic resources in the form of sound recordings, but are in danger of losing them because of a lack of basic preservation knowledge. A park may have a collection of oral history tapes, for example, but not realize that they must be given the same kind of attention as historic artifacts or furnishings if they are to last. Typically, the tapes are kept in a filing cabinet or closet with no thought given to proper condition of storage or use.

While it is true that a transcript of a tape can preserve the bare bones of the information content, hearing the actual recording is necessary to pick up a speaker's intonation, dialect, pacing — in short, a personality as revealed by voice. Other kinds of recorded information cannot even be translated to paper — musical performances, sounds of insects and wildlife, sounds of the operation of antique machinery, for example. To preserve this kind of information for the future, and provide a richer interpretive experience for the visitor, attention to the preservation of sound recordings is needed.

Sound recordings more often than not are in the form of magnetic tapes, so the guidelines given below will mainly concern their storage and use. A brief discussion will also be included for other recording formats such as shellac 78s, vinyl LPs and wax cylinder records.

Thinking About Preservation

Keep in mind that recordings are only part of a larger electro-mechanical system. Elements include microphones, amplifiers, tape decks, recording heads, turntables, tonearms, styluses, earphones, speakers, and, of course, wires. Preserving the recording is not enough. One needs space and equipment for playback, equipment that will not unduly damage the recording, yet reproduce it with fidelity, and also be convenient to operate and maintain. Our concern is with both the preservation of the physical object itself, and also with the preservation of its sonic content. Thus a preservation program will have to consider both conditions of storage and the conditions required for use and playback.

Guidelines for Storage

A. General requirements

1. Stabilize Temperature and Relative Humidity

It is important that *fluctuations* in temperature and relative humidity be minimized. Alternate swelling-shrinking and expanding-contracting of recorded materials can cause stresses, deformation, and even breakage, and can lead to distortion or loss of sonic content.

2. Control Temperature and Relative Humidity Extremes

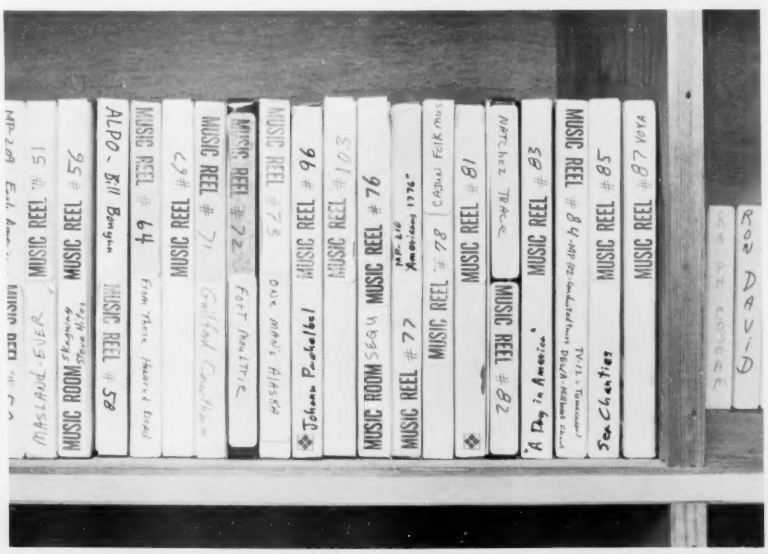
It is important to avoid *extremes* of temperature and relative humidity. Conditions of 70°F (21°C) and 50 percent relative humidity, with variation in either no greater than 10 percent, can be considered favorable.

These conditions can be controlled by building air conditioning/heating units, window air conditioners, or portable humidifiers/dehumidifiers, as needed. Enclosure in cabinets buffers fluctuations of the environment. Basements liable to dampness and attics liable to overheating should be avoided.

3. Exclude Dust

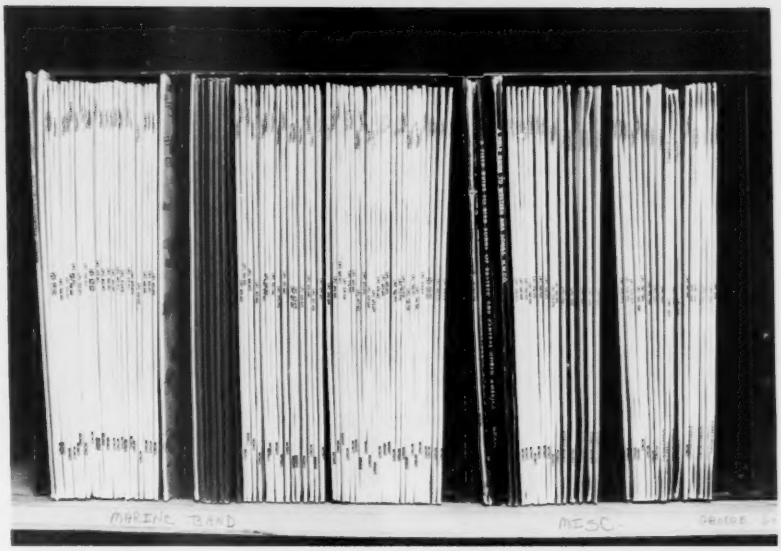
Dust is abrasive and can interfere with playback causing inferior reproduction and tape head wear. It can become permanently imbedded in discs.

Dust damage can be controlled by keeping recordings in their appropriate packaging, placing them in cabinets with doors, by



Tape reels should be enclosed in polyethelene bags to keep all dust out and stored in their individual boxes in a vertical position. All photos by J. Michael Wiltshire

Disc recordings should be stored upright in lined jackets. For vinyl LPs, the liners should be polyethelene; for shellac or nitrate 78s, liners should be acid-free paper jackets, never polyethelene. Use partitions every 4 inches (10 cm) to keep records from leaning and warping.



filtering the air conditioning system, and by regular vacuum cleaning of storage and playback areas.

4. Monitor Ambient Conditions
Temperature and relative humidity should be monitored to detect fluctuations and extremes and counteract them before damage is done. A recording hygrothermograph will keep a record of both values on a chart for a week. Least expensive would be sling psychrometer for spot humidity readings. This instrument is needed also to calibrate a hygrothermograph.

5. Provide Physical Security
Provision should be made for smoke detectors, fire extinguishers, locks to reduce the risk of theft, and locating storage to be free of risk from fire, flood, burst pipes, overheating, and other sources of harm.

B. Storage of Magnetic Tapes

1. If possible, use 1.5 mil mylar reel-to-reel tape. Thinner tapes, including those in cassettes, can stretch or break, and are more liable to print-through (part of the signal transferring to an adjacent tape layer causing an "echo" effect). Mylar has little inherent vice and should last in long-term storage. The signal and the metal oxide layer should also last in good storage. However, if poorly manufactured, mylar may contain residues which can cause deterioration. To test it, burn a small piece of the tape. A green flame indicates that the tape is unsuitable for long term storage. Any recordings made on this tape should be dubbed onto mylar tape that contains no residues.

2. Avoid cellulose-acetate tapes. These tapes are inherently unstable. They become brittle, decompose, expand with high temperature and humidity, and have low tensile strength. Recordings made on this tape should be dubbed onto mylar.

3. Tapes are sensitive to variations in temperature and relative humidity. Try to keep temperatures steady with variations no more than plus or minus 5°F or 2-3°C. Keep humidities in a range of plus or minus 10 percent. To minimize print-through and fungus growth at splice sites, do not exceed 70°F (21°C). Sixty degrees F (15.5°C) would be better, if possible. Keep humidities about 50 percent.

4. Dust can cause sound loss in playback and can physically damage both the backing and coating of the tape. Keep tape reels in polyethylene bags, and then place them in individual boxes.

5. Store tapes on shelves in their individual boxes. Place boxes in a vertical position. This will ensure that the reels will not lean and distort under pressure.

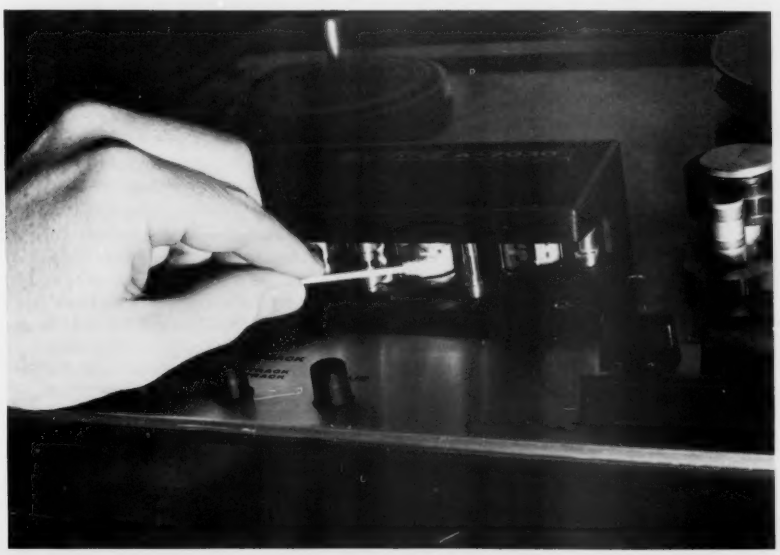
6. Store tapes "tails-out", i.e., as wound on the take-up reel at playback speed. Rewinding or winding at high speed causes high and uneven tension, made visible by ridges on the side of the reel of tape. Tapes are therefore rewound prior to playing, then played through and stored from the take-up reel.

7. Keep recorded tapes at least 3 inches (7.5 cm) from electrical conduits, electric motors, or other strong magnetic fields. There is little danger of accidental erasure if this rule is adhered to. Some archivists recommended wood shelves, but there is yet no evidence against metal.

8. While tape cassettes are convenient to record, store, and play, they are not suited for long term storage and use. Cassette recordings should be transferred to 1.5 mil reel-to-reel mylar. Cassette tapes, especially in the long play cassettes, are thin, easily snarl, break, and are liable to print-through. If they must be used for recording, use the best quality tape, the shorter lengths (60-90 minutes) and those which have cases with screw fittings so snarls can be untangled and splices made. Keep in individual plastic boxes, in the same environment as reel-to-reel tapes.

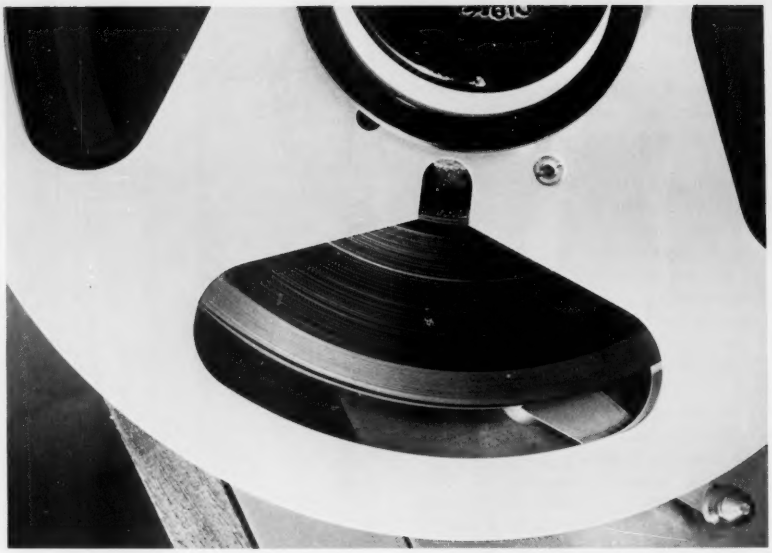
Storage of Discs and Cylinders

1. First find out what materials you have—vinyl LPs, polystyrene 45s, shellac or acetate or nitrate 78s, or wax cylinders or variations of these.



Clean magnetic heads, pinch rollers, guides or surfaces that contact the tape after 8 hours of use with cotton swabs and pure alcohol.

Check reels for smooth, even winding with no ridges. Ridges indicate adjustments are necessary.



2. Store discs vertically on shelves, with partitions at least every 4 inches (10 cm). This is so records will not lean and warp. Arrange by size of disc.
3. Keep discs in jackets, and use polyethylene liners for vinyl LPs. Keep shellac 78s in acid-free paper jackets. Do not keep 78s in original multiple-records albums. Keep acetate and nitrate 78s also in acid-free paper jackets — never polyethylene.
4. Do not let the temperature fall below freezing (32°F or 0°C) or exceed 80°F (26.6°C).
5. Vinyl LPs, 45s, and many shellac 78s (but not laminated ones, like most Columbia 78s) may be wet cleaned before storage if there is visible debris. This will remove dust, mold, packaging particles. Immerse record in lukewarm distilled water to which up to 1 tablespoon of liquid detergent, or Kodak Fotoflo, is added. Wipe with soft cloth in circular motion, not across grooves. Wipe off with a dry cloth and dry in a rack in a dust-free place. Keep solution used for 78s and vinyl separate. Do not wet or wipe acetate on nitrate recordings. If necessary they may be degreased by immersion in Freon-TF.
6. Cellulose nitrate or acetate "instantaneous" 78 recordings of the 1930s and 1940s as well as polystyrene 45s are inherently unstable. Preservation of their contents will require taping onto 1.5 mil mylar.
7. Store cylinders vertically, slightly loose over cylindrical forms. Space enough to allow air flow. Cover to keep out dust. Do not wash; can be gently wiped with a clean velvet cloth. Should be dubbed onto tape.

Guidelines for Playback and Use

Sooner or later the tapes or discs or cylinders will need to be played back, at least once. Not only will proper equipment and conditions need to be provided, a written policy regarding all phases of storage, handling, and use of the recordings should be established. Proper equipment will help ensure that the playback itself does the least damage to the recording, while policies can establish when (or even if) a recording may be played, who will handle the recording and operate the equipment, when a recording should be dubbed onto tape, preventive maintenance procedures for the equipment, and the like. The conditions of use must be as safe as possible in terms of handling and playback equipment, while also allowing the full sonic values of the recording to be preserved and recovered.

A. Tape Playback and Use

Tapes are the preferred format for archival recording. There is less degradation of sonic quality with repeated playing with tapes than with discs. This depends, however, on proper handling and equipment maintenance.

1. Handling the tape

a. Keep handling of the tape itself to a minimum so no grease or oil from hands can build up to attract dust and mold.

b. Use a 6-foot (1.8 m) non-magnetic paper leader at the beginning and end of open reels. This prevents frayed ends, and helps keep the tape itself clean.

c. To reduce print-through, use 1.5 mil mylar metal particle tape, and do not permit the tape to be exposed to temperatures over 80°F (26.6°C). Remove reels from decks (tape players) immediately after use to reduce heat build-up.

d. Use quality tape players. Inferior equipment can put too much tension on the tape and stretch or break it.

e. Do your splicing work on an aluminum splicing block and use professional splicing tape. Do not use cellophane tape — it will ooze and stick together more than just the splice.

2. Maintaining the Equipment

a. Clean magnetic heads, pinch rollers, guides, or any surface that comes in contact with the tape after every 8 hours of use. Use Q-tips or cotton swabs and pure alcohol or Freon-TF. Use a rubber cleaner from Sony or TEAC for the pinch rollers, but these need not be cleaned as often as the heads. Cleaning

Do not touch records with bare hands; be especially careful to avoid touching the record grooves. Handle by the edges and center only, and never play any record more than once every 24-hours.

Records should be cleaned before playing. Use a brush such as the Discwasher record cleaning system, or a Decca carbon fiber brush.

regularly is necessary, even if the cotton swabs show no debris, because small amounts of the tape's magnetic coating come off through abrasion onto any surface over which the tape slides. This build-up can cause uneven tape motion, sound drop-out, head abrasion, or even cause a partial loss of signal. Special cleaning cassettes are available for cassette players.

b. Demagnetize tape heads and other metal parts in contact with tape after every 40 hours of operation. Demagnetizer and instructions are available from recording equipment suppliers. Demagnetization is necessary because the metal builds up a magnetic field from the tape, and this can pose a threat to the signal on the tape. If severe, partial erasure could result.

c. Check reels for a smooth even wind with no ridges. Problems in this area will have to be adjusted by a service technician.

d. Problems with head alignment, head wear, and bias and equalization adjustments, all of which can affect the quality of playback, will have to be handled by a service technician.

3. Equipment Selection

Proper equipment will ensure that the recordings will not be damaged and that the full quality of recorded sound will be heard.

a. Look for ruggedness of construction, high reliability, and flexibility of operation.

b. Choose the best quality cassette player to preserve the quality of reproduced sound, because the cassette format itself allows a lesser quality recording. One must get the most out of a cassette that it is capable of giving.

c. Use quality microphones in recording.

d. Use the best quality 1.5 mil mylar tape, and use the proper performance grade for the type of recording. Follow tape deck manufacturer's recommendations.

e. Consider noise reduction equipment, e.g., Dolby or dbx, to reduce or eliminate tape hiss. It is especially important in dubbing not to add additional layers of hiss. Be warned, however, that these systems, being proprietary, may not be available in the future if the manufacturer goes out of business. Since these systems modify the signal, if the proper equipment is not available, it may be difficult to get a proper playback. Keep a file with instructions and technical data on all equipment you acquire.

f. For wire recordings, we wish you good luck in finding equipment for playback. If you are successful, tape the contents of the wire recordings immediately.

B. Disc Playback and Use

Improper handling and equipment can cause permanent damage with resulting degradation of sonic content.

1. Handling

a. Avoid touching grooves with bare hands because the hand's natural oils and grease can attract dust and mold.

b. Do not replay more than once every 24 hours. The pressure of the stylus causes friction, stress, and high temperature. The vinyl or shellac must be allowed to relax after playing. Playing twice in a row causes the same wear as 50 to 100 playings spaced 16 hours apart.

c. Keep track of the number of times a disc is played. Some archivists recommend that a disc be taped after 10 playings and the tape used thereafter.

d. Cylinders, acetate and nitrate 78s, and other fragile recordings should be taped onto 1.5 mil mylar reel-to-reel tape with gentle and quality equipment, and the tapes used instead.

e. Avoid dust before, during, and after playback. Use a record brush (such as a Decca carbon fiber brush or the Discwasher record cleaning system) before and after play, and a "dustbug" (for example, Decca, also) during. (Avoid brushing acetate and nitrate 78s, or wax cylinders.)

f. Use antistatic device, such as Zerostat.

2. Equipment

a. Stylus tip shape and diameter are impor-

Reduce static and dust attraction before playing with a device such as Zerostat.

tant. See discussion in McWilliam's book.

b. Clean stylus with camel's hair brush, brushing from back to front, before each playing.
c. Use quality stylus; inspect for wear periodically.
d. Use cartridges capable of tracking at less than 2 grams arm pressure.
e. Tone arms that are separate from turntable (i.e., not intregral) provide the best performance. A poor tone arm will not position the cartridge correctly over the grooves and can cause undue wear.
f. Adjust tracking force to as light as possible consistent with the best sound. Get a device to measure tracking force, and check occasionally.
g. Turntables, preamplifiers, equilizers, filter sets, amplifiers, earphones, and speakers will affect the quality of sound, but do not affect the quality of preservation of the physical object.
h. Equipment to play cylinders so they may be taped without causing damage may have to be custom built.

Bibliography

Much reliance has been put on the discussion in Jerry McWilliam's *The Preservation and Restoration of Sound Recordings*, 1979, (The American Association for State and Local History, 1400 Eighth Avenue South, Nashville, Tennessee, USA 37203). See also "The Handling and Storage of Magnetic Recording Tape," (leaflet, available from 3M Company, Magnetic Audio/Video Products Division, 3M Center, Saint Paul, Minnesota, USA 55101), and George Cunha's *Conservation of Library Materials*, 2nd edition, 1971, (Scarecrow Press, Metchen, New Jersey). The following is out of print but contains much of the research data on which many of the above guidelines are based: A. G. Picket and M. M. Lemcoe, *Preservation and Storage of Sound Recordings*, 1959 (Library of Congress, Washington, D.C.).

Dan Riss is a Conservator at the Conservation Laboratories of the U.S. National Park Service, Harpers Ferry Center, West Virginia, USA.

Unisex Restrooms

Faster, more efficient maintenance makes this unisex restroom design, from Silverwood Lake State Recreation Area in southern California, a big hit with staff as well as visitors.

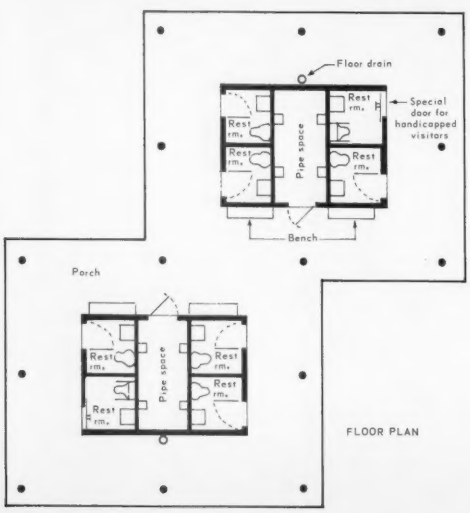
Each restroom building has from two to 12 units, structurally connected but functionally separate. Each unit contains its own toilet, washbowl, mirror, seat cover holder, tissue dispenser, liquid soap dispenser, and a built-in waste container that can be emptied from the service space between the units. A long, narrow window extends across the brick wall near the ceiling.

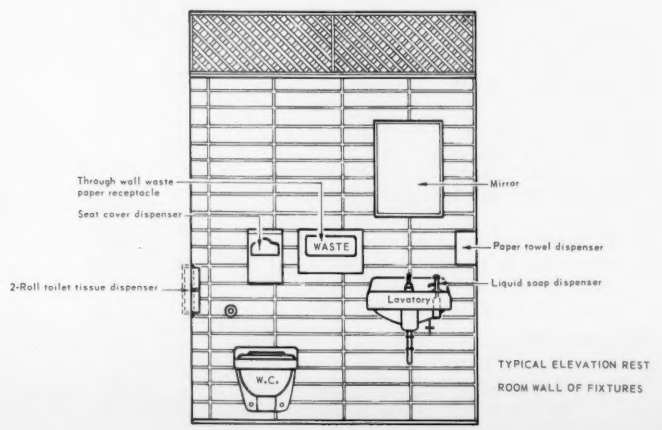
The door swings in so that the toilet is hidden from outside view. The knob-type door latch has an inside push-button lock which automatically unlocks when the door is closed from the outside. Wheelchair units have sliding rather than swinging doors and users have reported complete satisfaction with them.

To facilitate maintenance, the floor of each unit is drained through a slot in the wall out to a sewer drain in the service space between units. The central drain can be serviced without inconvenience to any of the restroom users.

With the individual unit design, maintenance personnel no longer have to wait until an entire ladies' room is unoccupied before beginning cleanup tasks. Nor must women visitors be inconvenienced by having the entire ladies' room closed for cleaning.

This design, by Wm. Penn Mott, Jr., is published here through the courtesy of DESIGN, a publication of the Park Practice Program which is sponsored by the Heritage Conservation and Recreation Service of the U.S. Department of the Interior in cooperation with the National Recreation and Park Association.





100 kW Solar Electricity System

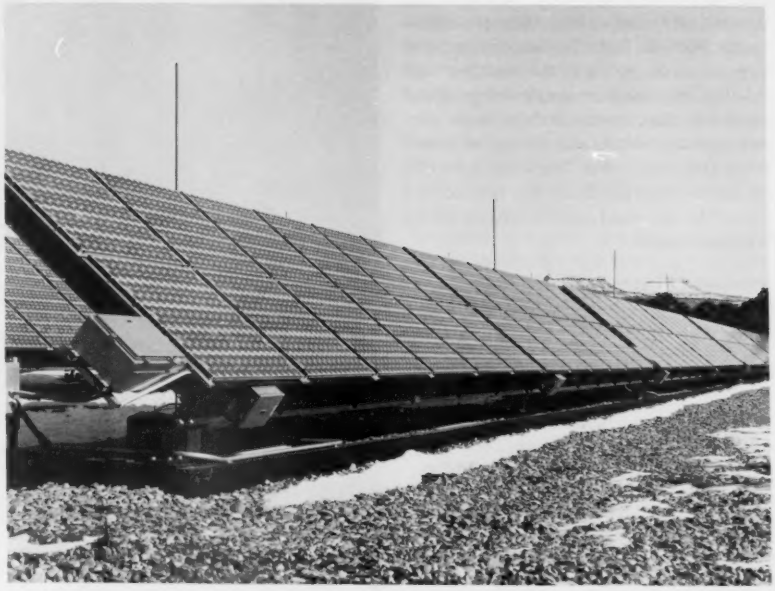
A 100-kilowatt photovoltaic energy system has been put into service at Natural Bridges National Monument, a U.S. National Park Service area in southeastern Utah, USA.

Photovoltaic power systems make use of solar cells that generate direct current electricity from sunlight. At Natural Bridges N.M., collector panels arranged in 12 long rows offer 989 square meters of solar cell area to the sun. This is the largest flat-plate photovoltaic system operating anywhere.

Energy from the system supplies the homes of park staff, maintenance facilities, the Visitor Center and a water-sanitation system.

Located nearly 40 miles (64 km) from the closest power line, Natural Bridges in the past obtained its electrical energy from two 40-kilowatt diesel generators that consumed an average of 1500 gallons (5678 L) of diesel fuel each month. The fuel oil had to be transported by truck from as far away as 130 miles (209 km).

Because many National Park Service areas are remote and depend heavily on generators for electric power, they are considered attractive potential sites for photovoltaic energy systems, particularly as the cost of solar cells is being reduced by manufacturing improvements. Today the price of photovoltaic cells is approximately half what it was in 1978 — US$10 per peak watt output. The Department of Energy hopes to reduce that price to 70 cents by 1986 and 15-30 cents by the year 2000.



Solar photovoltaic array at Natural Bridges National Monument contains 256,812 individual solar cells of 2 and 3-inch diameters (5 and 7.5-cm) in an array that covers .52 ha or 1.3 acres. At noon with full sunlight the system produces 100 kilowatts of direct current electricity. The MIT (Massachusetts Institute of Technology) Lincoln Laboratory, through its subcontractor, Ford, Bacon and Davis, Inc., of Salt Lake City, Utah, was responsible for design and installation of the photovoltaic system.

Solar Cells

Generating electricity directly from the sun depends on the photovoltaic effect. This occurs when light hits certain sensitive materials and creates a flow of electrons; that is, an electrical current. The basic units that accomplish this are called solar cells. The first practical solar cells were manufactured in the mid-1950s and were used to supply small amounts of power in such applications as remote weather equipment, and in the space program where they provided most of the electricity for a variety of space vehicles.

Silicon is a primary solar cell material. Its technology is highly advanced as a result of its use in the space program and in the electronics industry. It is the material from which transitors are manufactured. Other materials include cadmium sulfide, cadmium telluride, and gallium arsenide. All are semiconductors, which are a class of solid crystalline materials whose ability to conduct electricity is less than that of metals and more than that of insulators such as rubber.

A typical solar cell contains two very thin layers of silicon with an outside wire attached. In one layer, a few atoms in the silicon crystal have been replaced by boron atoms; in the other, the replacement atoms are phosphorus. Sunlight falling on the cell forces electrons to move along the wire from the phosphorus-silicon layer to the boron-silicon layer. Theoretically, a silicon solar cell should be able to convert about 25 percent of the sun's energy into electricity. In practice, 16 percent is the highest conversion achieved to date for mass-produced solar cells.

Solar cells can be connected electrically to form solar modules, which are the basic building blocks of solar electric systems. For example, 40 cells connected together provide enough electricity to charge a 12-volt automobile battery. — *U.S. Department of Energy*

Bog Walkway

This walkway over a bog at Ben Lawers National Nature Reserve, a property of the National Trust for Scotland, is constructed of old railroad ties or sleepers laid on joists which are anchored by stakes. The old timbers, originally treated with a preservative that still retards decay, make a stout, long-lasting and inexpensive boardwalk. *Photo: R. Standish.*

Wildlife: Past. Present. Future?

Here is a very effective educational poster used by the National Parks Service of Senegal to help inform the people of the need to protect wildlife. The idea is so simple and graphic it needs only three words (or dates) to be completely understood. As a lecture tool no printed words at all are needed. The poster is 50 x 70 cm and the three panels are red, magenta and white. The idea could easily be adapted for use in other countries.

BOOKS AND NOTICES

Indonesia to Host 1982 World Parks Conference

The World National Parks Conference 1982 will be held 11-22 October 1982 in Bali, Indonesia, under sponsorship of IUCN and Indonesia's Directorate of Nature Conservation. Theme of the conference will be "Protected Areas in a Changing World." General plans for the conference, the third to be held in 30 years, were accepted by IUCN in June following the report of a special planning committee, under P. H. C. Lucas of New Zealand, comprised of CNPPA (IUCN) members and representatives of the Government of Indonesia.

Secretary General of the conference will be Dr. Lukito Daryadi, Director of Nature Conservation for Indonesia. Effendy Sumardja will be Deputy Secretary General.

The conference will be held in air-conditioned facilities at the Bali Beach Intercontinental Hotel, Denpasar, where more than 300 participants can be accommodated.

As with both the First and Second World Conferences, the 1982 conference will be a non-governmental meeting. It is expected that visas will be available for all eligible participants.

Further details will be announced as planning for the conference progresses.

New Zealand Issues Two Publications on Walkways

The successful establishment of a system of walkways in New Zealand has produced not only the 40 walkways now in place but two new publications of interest.

These are the booklets, "New Zealand Walkway Commission Policy Statement 1980," and "A Guide to Walkway Construction and Maintenance."

Professional readers of PARKS having particular interest in the walkway concept can obtain copies by writing to The Secretary, New Zealand Walkway Commission, Department of Lands and Survey, Head Office, Private Bag, Wellington 1, New Zealand.

CNPPA Establishes Award for Valor in Performance of Duty

After several years of planning and fund-raising the IUCN Commission on National Parks and Protected Areas (CNPPA) formally has established an International Park Valor Award. The Award is in the form of a medal, certificate, and monetary honorarium (or scholarship).

It will be given periodically, probably once a year, depending on the income from the invested funds established to finance the award.

The Valor Award will be give to honor rangers, wardens, guards or other paid staff personnel in recognition of exceptional deeds, calling for physical or moral courage beyond the call of duty, performed to safeguard wildlife or other natural or historic resources within national parks or other categories of protected areas anywhere in the world. The award may be given posthumously, or divided among two or more individuals. As a matter of general principle only field personnel will be considered as recipients.

The award is administered by the Chairman of CNPPA and a committee. Recommendations of individuals who may be considered as candidates for the Valor Award should be forwarded to the Executive Officer, CNPPA, IUCN, 1196 Gland, Switzerland, together with full documentation concerning the incident of valorous performance. The incident should have occurred during the preceding three years.

Basic planning, fund raising and other details leading to establishment of the Valor Award by the Commission were handled by a committee under Fred M. Packard, Chairman.

Conservation Awards for Latin America Established by Florida Audubon Society

As part of its long-standing work in international conservation, the Florida Audubon Society (USA) has established an ongoing program of awards to dynamic young conservation leaders in Latin America. The program, sponsored by private donors, will provide for two $1,000 awards annually to individuals inside or outside of government, generally under 35 years old, who have made major contributions to conservation in Latin America.

The unanimous choice of the selectors for the first award is Angela Tresinari Bernardes Quintão, of Brazil. Ms. Quintão is the Director of the Division of National Parks and Renewable Natural Resources of the Brazilian Institute of Forestry Development. The award was made for the major role she played in a number of notable conservation achievements, including the preparation of several National Park management plans, a national strategy plan for conservation units, and since June 1979, the establishment of five new parks and reserves with a combined area of nearly 3.5 million ha, mostly in the Amazon basin.

Editor's Note of Appreciation

C. Gordon Fredine for many years was Chief of the Division of International Park Affairs for the U.S. National Park Service in its Washington headquarters. He capped a long formal career in wildlife conservation, habitat conservation and academic service with a year to plan and conduct the 2nd World Conference on National Parks, held in September 1972. He retired the following June.

But like so many active men, Mr. Fredine was not content to simply rest. Among a number of active pursuits, he found time to work on a volunteer basis as Assistant Editor of PARKS Magazine from the early planning exercises through the first 4½ years of publication. He brought unique experience, world-wide contacts and seasoned good judgement to the journal. These qualities are invaluable and cannot be replaced.

Gordon has decided to accept a new invitation, this time in a position which precludes regular service for this journal. As Executive Director of The Renewable Natural Resources Foundation in Washington, D.C., his time will be fully committed.

Our thanks to you, Gordon, for all you have done to make PARKS the success it has become, and good luck in your new endeavor.

Robert I. Standish

The Complete Guide To America's National Parks. 1979. Quirk, Patrick J. and Thomas F. Fise. National Park Foundation, Washington, D.C. 292 pp. US $5.80 for a single copy includes handling and shipping. Price for orders from outside the USA is US $6.39, including handling and postage.

Many guide books to the vast US park system have been prepared, but most older books are somewhat out of date due to the significant number of new areas added during the last few years. This Guide is not only complete; it is a particularly good one.

Organized by states, alphabetically, entries contain data on each park area's location, mailing address, directions to get there (often rather extensive and detailed), a full description of visitor activities, and general information covering such items as accommodations, food, weather, recommended clothing and equipment, insects and wildlife, etc.

Lists of peak visitation periods for each area, an index, and a summary of the US National Park System by classification and area are included.

The Park Buffalo. 1979. Sheilagh C. Ogilvie. National and Provincial Parks Association of Canada, P.O. Box 7156, Postal Sta. E., Calgary, Alberta T3C 3MI, Canada. 68 pages, paper. US $4.95 plus $.50 postage in Canada and USA, $1.00 postage in other countries.

This little book reveals the saga of the North American bison (buffalo) from its once great abundance, estimated at 60 million animals in the 18th century, to its near extinction in the 19th century, followed by its almost miraculous rescue from oblivion. Not only is this a fascinating story but it reveals how only a few dedicated people can save endangered species, and tells about the pitfalls and dangers associated with the distribution of serious diseases and the loss of pure genetic strains that can result from unknowing and thoughtless reintroductions. The national park movement is given the primary credit for the original preservation effort, and for its continuing success. The American bison can never again attain more than a tiny fraction of its original abundance, but its survival seems assured. — *C. G. Fredine*

PARK VIEWPOINTS

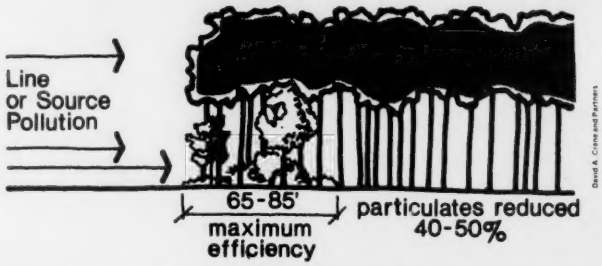
Nature's Scrubber

Virginia Worthington

The role vegetation plays in air purification has been described by many researchers and plant pathologists who have closely monitored the absorption, respiration and transpiration activities of individual plant species. It has been only within the last decade, however, that its role in mitigating air pollution has received major attention. A recent study contracted by the Environmental Protection Agency (EPA) entitled "Open Space As An Air Resource Management Measure" attempts to draw together pertinent data and information available on this subject worldwide and assess how effective open space is in filtering various airborne pollutants. The findings, though hampered by serious informational shortcomings, suggest that, given a proper management and landscape design plan, open spaces, such as green belts, highway rights-of-way, and urban parks, can be utilized to significantly reduce the spread of air pollution from both stationary and mobile sources; in some instances at levels far more cost effective than traditional control methods.

According to the researchers involved in the study, open spaces, with their associated vegetation and soil mixes, act as natural "sinks" for air pollutants through several mechanisms. Through such processes as absorption, adsorption, impingement and deposition, open spaces can entrap pollutants generated by urban land uses. For example, leaf hairs (trichomes) on deciduous trees act as a natural catch for particulates. Soil microorganisms metabolize carbon monoxide gases, providing an ideal sink for one of the most insidious automobile emissions. Similarly, sulfur dioxide (SO_2, a by-product of the combustion of fossil fuels) passes into plants through leaf stomata, where it is then converted into organic sulfur and assimilated by the plant. One researcher, in a study of the atmospheric concentration of sulfur dioxide in mid-Manhattan (New York City), found a significant drop in the SO_2 level created by the presence of Central Park. And, depending upon such environmental conditions, a variety of other "sinks" exist. In short, the study concludes that, "Open space, in its natural state or manipulated state, can have a varied and far-reaching effect on regional air quality . . . The use and design of open space areas on a micro-scale can mitigate pollution transport characteristics." The report further notes that "The knowledge obtained from the investigation of open space as an air quality maintenance strategy should be used to re-evaluate the concept of the atmosphere as a sink. Historically, our view has been to dilute the pollutants with the atmosphere. However, vegetation and open space can be utilized as a sink or filtering device."

But the study carries the data several steps further and attempts to describe how these "sink" characteristics can be maximized through various design configurations. For example, different plant and soil types have different abilities to absorb and adsorb pollutants—termed a "sink factor." Beech, unlike the Norway Maple, is extremely tolerant to oxides of nitrogen (NO_x). In addition, the density, permeability and diversity of an open space buffer directly affect its ability to remove air pollutants. Pollutant removal is maximized when a forest buffer is *moderately* permeable; one which is well stratified by the presence of ground cover, an understory, and an upper tree level. However, a forest buffer that contains a dense "wall" or overlapping of layers can actually hinder the



passage of wind through the forest, thereby reducing the exposure of air pollutants to the vegetation. Similarly, the report notes, that in at least one study it was concluded that the initial 65 to 85 feet (20-26m) of the forest edge can reduce the concentration of particulates by as much as 50 percent. Such removal, the report determines, can be enhanced by increasing the diversity of the plant species located within the first 65 to 85 feet of a greenbelt. Using such design criteria as briefly highlighted above, the study then devised various hypothetical models in which open space management practices were introduced. Specifically, the study used St. Louis, Missouri, USA, as a test city.

Perhaps the most encouraging aspect of the open space management plan is the multiple benefits it directly and indirectly generates. By maintaining stretches of open space prime urban recreation and refuge areas are created, noise levels are muffled, and the visual blight often associated with high density development is soothed by the presence of green vegetation.

Open space is not, however, a single panacea to air pollution. As the report notes, such plans are not feasible for the removal of all pollutants. Based on the demonstration study and comparative cost analysis conducted in St. Louis, researchers concluded that while space plantings were feasible for removing sulfur dioxide (actually 3½ times less expensive than scrubbers for the same degree of effectiveness), it was economically infeasible to rely on such practices for the removal of particulates like lead. Rather, their studies demonstrated that the use of mechanical devices, at the source, provided a far more cost effective control technology for particulate removal. More importantly, the report strongly cautioned that the dearth of quantitative information on the subject severely limited the reliability of the sink and emission factors derived in the study. Questions regarding the impact of the accumulation of pollutants (including such toxic substances as lead and fluorine in soils and vegetation) on soil fertility, groundwater quality and food chains, were left unanswered. And the study noted that the use of open space without a close evaluation of the entire community infrastructure could have an actual negative impact on air quality. If, for example, the isolation of large tracts of open space resulted in an increase in vehicular travel, total levels of emissions from mobile sources could increase. Further research will no doubt be required before such laboratory data can be extrapolated and used on the macro-level. But the preliminary data point toward the optimistic conclusion that protection of open spaces may have more than aesthetic value.

Virginia Worthington is a former editor of "Conservation News," an educational service of the National Wildlife Federation. This article is reprinted from the issue of August 15, 1977.

Whenever the sun shines on the array of photovoltaic cells pictured here electricity is produced. Peak output is 100 kilowatts. The electricity flows to a lead-acid battery large enough to supply all the power normally needed for two days at Natural Bridges National Monument in Utah, USA. The system serves the visitor center, several houses, a four-unit apartment building, pumps, and a maintenance facility. The U.S. National Park Service has applied smaller but similar photovoltaic systems to furnish electricity for communications devices, battery chargers, oil-flush septic systems and weather stations, all with good results. Steadily increasing use of photovoltaic systems is foreseen due to reduced costs expected to result from improved technology and growth. Photo: Frank Mendonca, Moab, Utah.

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